Draft Final Feasibility Study

Martin Aaron Superfund Site
Camden, New Jersey

Prepared for

U.S. Environmental Protection Agency
Region II

July 2005

Prepared by

CH2MHILL

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Acronyms

1,1-DCE	1,1-dichloroethene
ARARs	Applicable or Relevant and Appropriate Requirements
Bgs	below ground surface
CEA	Classification Exception Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis 1,2-DCE	cis 1,2-dichloroethene
COC	Contaminant of Concern
COPC	Chemicals of Potential Concern
DAF	Dilution Attenuation Factor
DO	Dissolved oxygen
DOT	Department of Transportation
ELCR	Excessive Lifetime Cancer Risk
FS	Feasibility Study
FR	Federal Register
GAC	Granular Activated Carbon
Gpm	gallons per minute
GWQC	Ground Water Quality Criteria
HI	Hazard Index
HHRA	Human Health Risk Assessment
IGWSCC	Impact to Groundwater Soil Cleanup Criteria
LDR	Land Disposal Restriction
MCL	Maximum Contaminant Limit
MDL	Method Detection Limit
NCP	National Contingency Plan
NJDEP	New Jersey Department of Environmental Protection
NPL	National Priority List
NRDCSCC	Non-residential Direct Contact Soil Cleanup Criteria
O&M	Operations and Maintenance
POTW	Publicly Owned Treatment Works
PCB	Polychlorinated Biphenyls
PCE	tetrachloroethylene
PRGs	Preliminary Remediation Goals

PRM	Potomac-Raritan-Magothy
PVC	polyvinyl chloride
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RDCSCC	Residential Direct Contact Soil Cleanup Criteria
RI	Remedial Investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SJP	South Jersey Port Company
SSL	Soil Screening Level
SLERA	Screening-Level Risk Assessment
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
TBC	To Be Considered
TC	Toxicity Characteristics
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TMV	Toxicity, Mobility or Volume
ug/kg	Microgram per kilogram
ug/L	Microgram per liter
EPA	U.S. Environmental Protection Agency
USGS	U. S. Geologic Survey
UTS	Universal Treatment Standard
VOC	Volatile Organic Compound

1.0 Introduction

1.1 Purpose and Organization of Report

This Draft Feasibility Study (FS) report documents the development and evaluation of remedial action alternatives for the Martin Aaron Superfund Site (Martin Aaron Site) located in the City of Camden, Camden County, New Jersey. This work was performed for the United States Environmental Protection Agency (EPA) in accordance with the Work Assignment No. 953-RICO-02MN under RAC Contract Number 68-W6-0036.

The EPA, in consultation with the New Jersey Department of Environmental Protection (NJDEP) and with input from the public, will use this information to select a remedial action alternative in its Record of Decision (ROD) in accordance with the National Contingency Plan (NCP). The criteria for remedy selections under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) require that Superfund remedial actions satisfy the following requirements:

- Protect Human Health and the Environment;
- Comply with Applicable or Relevant and Appropriate Requirements (ARARs) of Federal and State Environmental Laws within a Reasonable Time Frame;
- Be Cost-Effective;
- Use Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable; and
- Satisfy the Preference for Treatment that Reduces Contaminant Toxicity, Mobility, or Volume (TMV).

As described in the *Remedial Investigation/Feasibility Study* guidance document (EPA, 1988) and in the EPA 1990 *National Oil and Hazardous Substances Contingency Plan*, the FS consists of three phases: the development of remedial alternatives, the screening of alternatives, and the detailed analysis of selected alternatives. The following steps were used in developing the remedial alternatives for the Martin Aaron Site.

- Identify ARARs;
- Develop Remedial Action Objectives (RAOs);
- Define remedial action goals, that include:
  - Developing quantitative Preliminary Remediation Goals (PRGs) using chemical-specific ARARs and human health- and ecological-based risk levels;
  - Identifying areas of contamination exceeding PRGs;
- Develop general response actions;

- Identify and screen technologies (including innovative technologies);
- Identify and evaluate technology process options;
- Assemble remaining process options into remedial alternatives; and
- Evaluate the remedial alternatives in accordance with the NCP.

This report consists of six sections. Section 1 includes the introduction and summarizes background information, such as site physical description, site geology and hydrogeology, nature and extent of contamination, contaminant fate and transport, and a summary of human health and ecological risks. The development of the ARARs, RAOs, and PRGs that are intended to provide adequate protection of human health and the environment are discussed in Section 2. Chemical-specific remedial goals were developed for soil and groundwater based on risk associated with the various concentrations of contaminants in those media, ARARs, and background concentrations, where applicable. Section 3 develops general response actions that address remedial action goals and introduces the identification and.screening of the technology types and process options. Remedial technologies were screened to reduce the number of technologies considered in the detailed alternatives. Section 4 assembles the remaining technologies into soil and groundwater remedial action alternatives that achieve some or all of the remedial action goals, and provide a range of levels of remediation and a corresponding range of costs. A detailed analysis of these soil and groundwater alternatives is presented in Section 5. Section 6 includes references used during the preparation of this FS.

1.2 Site Description

EPA's Remedial Investigation (RI), dated December 2004, defined the Martin Aaron Site as five individual properties. The properties are identified on Figure 1-1 as follows:

1. The 2.4 acre Martin Aaron property; located at 1542 South Broadway in the City of Camden, Camden County, New Jersey (Lot 1, Block 260);
2. The South Jersey Port Corporation (SJPC) property located west of the Martin Aaron property, at 1535 South Broadway (Lott 15, Block 458);
3. An active scrap yard to the north of the Martin Aaron property between Broadway and Sixth Street on Everett Street;
4. Comarco Products, an active meat processing plant located at 501 Jackson Street; and
5. An abandoned warehouse owned by the Ponte Company located south of the Martin Aaron property on Sixth Street.

From 1969 to 1985, Martin Aaron Incorporated operated a drum recycling business. Currently, the Martin Aaron property is abandoned and access is restricted by a chain-linked fence with two locked gates. The only remaining surface structure on the Martin Aaron property, the Rhodes Drum Building, is located on the southeastern portion of the property. Prior to demolition activities, the property consisted of a main building identified as the former Martin Aaron Building. The Rhodes Drum Building and now-demolished Martin Aaron Building were both used for drum recycling and reconditioning operations.

The scrap yard to the north of the Martin Aaron property and Comarco Products (south of the Martin Aaron property) are both active facilities. The Ponte Company property, which is also south of the Martin Aaron property, is an abandoned warehouse. Two commercial buildings occupy the SJPC property. The remaining acreage consists of paved and unpaved surfaces. The SJPC property was leased by Martin Aaron Inc. and used for office space, and drum receiving and sorting.

During EPA's RI, the SJPC was approached by a non-profit organization interested in purchasing the SJPC property. Since the SJPC property is included as part of the overall Martin Aaron Superfund Site, the prospective purchaser requested formal approval from NJDEP and EPA to allow the sale to proceed. NJDEP reviewed the conditions at the SJPC property and recommended, with EPA concurrence, to address the SJPC property separately from the Martin Aaron Superfund Site.

NJDEP, who assumed the responsibility for addressing the conditions found at the SJPC property, and the SJPC property owner, evaluated potential remedies for the SJPC property. After evaluating previous uses of the SJPC property and previously completed EPA/NJDEP sampling results, NJDEP concluded that contamination at the SJPC property could be attributed to "historic fill" in the area, and not to the Martin Aaron Site as described in Section 1.5.1 "Historic Fill" below. For example, Martin Aaron Inc. leased only a portion of the SJPC property, and sample results in areas used by the Martin Aaron operation had similar results when compared to areas not used by Martin Aaron. NJDEP also determined that the contamination on the SJPC property, primarily metals and PAHs, did not appear to be a source of groundwater contamination in the area.

Given these supportive conditions, NJDEP, with EPA's concurrence, plans to proceed with a remedy for the SJPC property, independent of the Martin Aaron Site. NJDEP's Technical Regulations require that if "historic fill" material is not treated or removed from a site, engineering and institutional controls shall be implemented. Some form of engineering control, such as an asphalt cap, would be required at the SJPC property prior to reuse, along with a deed notice to assure the long-term maintenance of the cap.

Therefore, EPA has elected to proceed with completing the RI/FS without further remediation at the SJPC property. EPA's FS now includes only four individual properties, which comprise the Martin Aaron Superfund Site. The properties are identified as follows:

1. The 2.4 acre Martin Aaron property; located at 1542 South Broadway;
2. An active scrap yard to the north of the Martin Aaron property between Broadway and Sixth Street on Everett Street;
3. Comarco Products located at 501 Jackson Street; and
4. An abandoned warehouse owned by the Ponte Company located south of the Martin Aaron property on Sixth Street.

1.3 Site Background

1.3.1 Site History

Between 1981 and 1983, inspections conducted by the EPA and the NJDEP identified unpermitted discharges of hazardous wastes from leaking drums and roll-off containers. Sampling events conducted by the NJDEP between 1986 and 1993 identified organic and inorganic constituents in sewer basins and drums at the property.

The NJDEP conducted a three-phased Remedial Investigation (NJDEP RI) at the Martin Aaron Site between May 1997 and March 2000. The results of the NJDEP RI determined that surface and subsurface soils at the Martin Aaron Site contained levels of organic and inorganic constituents in excess of the NJDEP soil cleanup criteria. The primary constituents of concern within the surface and subsurface soil included chlorinated and aromatic volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals. The results of this NJDEP RI also showed that shallow groundwater was contaminated above the NJDEP Groundwater Quality Criteria (GWQC); including chlorinated and aromatic VOCs, SVOCs, pesticides, PCBs, and metals.

The lead for Site activities was transferred to EPA at the time of listing on the National Priorities List in 1999. CH2M HILL conducted an additional investigation of the Martin Aaron Site for the EPA between October 2001 and September 2002 (EPA RI). As part of the EPA RI, additional groundwater monitoring wells were installed and sampled, and surface and subsurface soil samples were collected. The results of the EPA RI conducted in 2001 and 2002 confirmed the presence of VOCs, SVOCs, pesticides, PCBs, and metals in soil and groundwater on both the Martin Aaron property and surrounding properties. Details of the investigation activities completed at the Site between 2001 and 2002 are detailed in the *Remedial Investigation Report,* dated December 2004 (CH2M HILL, 2004).

1.4 Site Geology and Hydrogeology

The Martin Aaron Site is located in the New Jersey Coastal Plain physiographic province in an area with moderate thickness of highly permeable, unconsolidated sediments of the Pleistocene and Cretaceous age which outcrop beneath the Martin Aaron Site. Soils at the Martin Aaron Site are Pleistocene age deposits of the Freehold-Downer Urban Land Complex soil associations. The unconsolidated sediments immediately underlying the Pleistocene deposits consist primarily of sands and gravels with intervals of silts and clays classified as continental, coastal, or marine type deposits.

The Martin Aaron Site is located within the outcrop area of the Potomac-Raritan-Magothy (PRM) Aquifer System. Six time-stratigraphic units beneath the Site can be categorized into hydrostratigraphic units according to their hydraulic properties and significance. The Site is underlain by three aquifers and three confining units as follows: the Upper PRM Aquifer, an intermittent confining unit that includes interbedded sand, the Middle PRM Aquifer, a continuous clay confining unit, the Lower PRM Aquifer, and a basal confining unit. The Upper and Middle PRM Aquifers were evaluated for this RI.

The Upper PRM Aquifer is under unconfined conditions and consists of sandy soils of the Magothy Formation in hydraulic connection with the surficial anthropogenic fill materials. The Upper PRM Aquifer ranges in thickness from 94 ft to 110 ft. The Surficial Upper PRM Aquifer is underlain by an intermittent confining unit that separates the Upper PRM from the Middle PRM Aquifer. The Middle PRM consists of sands and gravels of the Potomac Formation approximately 100 ft thick.

The nearest surface water body to the Martin Aaron Site is the Delaware River, which is located approximately 0.75 miles to the west. Additional surface water bodies include the Cooper River, which is located approximately 2 miles north-northeast of the Martin Aaron Site, and Newton Creek, which is located approximately 1.5 miles south of the Martin Aaron Site.

Groundwater flow direction in the Upper PRM Aquifer is generally to the southeast, away from the Delaware River, along a gradient ranging from 0.0069 ft/ft to 0.011 ft/ft, depending on the depth in the Upper PRM Aquifer. Within the surficial Upper PRM Aquifer, groundwater is not tidally influenced. However, in the Middle Upper PRM Aquifer, groundwater is tidally influenced. Hydraulic conductivities in the Upper PRM Aquifer range from approximately $1x10^{-2}$ to 99 ft/day (Surficial Upper PRM Aquifer) to 1.12 to 3.27 ft/day (Middle Upper PRM Aquifer).

Groundwater is not used as a drinking water source at the Martin Aaron Site. Camden County Municipal Utility Authority (CCMUA) provides drinking water to the City of Camden using water supply wells which draw water from the PRM Aquifer System. CCMUA provides drinking water to approximately 105,000 people within four miles of the Martin Aaron Site. The nearest CCMUA well is located approximately 1.75 miles to the east-northeast of the Martin Aaron Site.

1.5 Nature and Extent of Contamination

The following sections provide details on the nature and extent of soil and groundwater contamination identified during the EPA RI at the Martin Aaron Site. This section focuses on the historic fill, soil and groundwater media, which are the focus of the remainder of the FS.

1.5.1 Historic Fill

The Martin Aaron Site is situated in an urban, mixed industrial and residential setting. As previously mentioned in Section 1.3.1 "Site History", both EPA and NJDEP conducted separate and independent RIs from 1997-2000 (NJDEP) and 2001-2002 (EPA) in order to define the extent of soil and groundwater contamination at the Site. The contamination is believed to be a direct result of previous drum recycling operations. While conducting these independent investigations, both EPA and NJDEP found that metals in soils were widespread across the Martin Aaron property and the neighboring properties.

As part of EPA's investigation to obtain a more complete understanding of the presence of metals in soils at Martin Aaron, EPA reviewed a 1979 map called the "Historic Fill of the Camden Quadrangle" obtained from the NJDEP, see Figure 1-1A. This map identifies that the Marin Aaron Site is located within a historic fill material area in the City of Camden.

Historic fill material is considered to be a non-indigenous material placed on a site in order to raise the topographic elevation of that site.

The NJDEP RI findings also concluded that the majority of the Site is underlain by seven to 12 feet of man-made fill material consisting of ash, cinders, brick, concrete, and other debris. The fill layer was found to be fairly consistent beneath the Martin Aaron property with less cinder and ash fill observed beyond the property borders. Similarly, less undifferentiated fill material was identified in borings completed beneath the southern portions of the former Martin Aaron building and beneath the central and southern portions of SJPC located immediately to the west, across the street from the Martin Aaron property. These results indicate that the fill may also be the results of past operations at the property which historical records show once contained several large smoke stacks. Excavated test pits encountered fill consisting of ash, cinders, brick, concrete, scrap metal at almost all excavation locations.

EPA's RI found that man-made fill consisting of the items previously noted above, ranged from 6 to 10 feet below ground surface throughout the Site, confirming NJDEP's findings. EPA's RI soil sample results found that metals above EPA and NJDEP screening levels were detected in virtually all surface soil samples collected from the Martin Aaron property and surrounding properties. The highest concentrations of metals consisted of arsenic and lead, which were found in former operational areas at the Martin Aaron property. This indicates that these compounds may also have some site-related contribution. Soil sampling also discovered that elevated PAHs were found only in subsurface soil upgradient from the Martin Aaron property in the northeastern corner of SJPC. This area of contamination is most likely the result of operations at a former service station adjacent to the SJPC property.

Overall, both RIs confirmed that metals found at Martin Aaron and the surrounding properties are associated primarily with the presence of historic fill material and not exclusively from the past drum recycling operations at Martin Aaron.

1.5.2 Soil Contamination

During the EPA RI, soil concentrations detected in collected samples were compared to the EPA Generic Soil Screening Levels (SSL) for Migration to Groundwater, the NJDEP Impact to Groundwater Soil Cleanup Criteria (IGWSCC), and the NJDEP Non-Residential Soil Cleanup Criteria (NRDCSCC) for each constituent detected. The following is a summary of the results of the EPA RI for surface (0-2' below ground surface (bgs)) and subsurface soils (2' bgs to depth of boring).

Surface Soil

- VOCs were detected above screening levels in samples collected from the Martin Aaron property, but not the surrounding properties. The most commonly detected VOCs in surface soil on the Martin Aaron property include tetrachloroethylene (PCE), trichloroethylene (TCE), cis-1,2-dichloroethylene (cis-1,2-DCE), vinyl chloride, and benzene.
- SVOCs were identified at the Martin Aaron property, Comarco Products, and the Ponte Company properties at levels above screening levels in surface soils. The SVOCs detected most frequently include: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, carbazole, dibenzo(a,h)anthracene,

fluoranthene, indeno(1,2,3-cd)pyrene, n-nitrosodiphenylamine, pentachlorophenol, and pyrene.

- Metals above screening levels were detected in virtually all of the surface soil samples collected from the Martin Aaron Site. Metals are present at elevated concentrations in soil samples collected at locations upgradient of the Martin Aaron Site, and are at locations away from drum recycling operations. Therefore, it is suspected that metals are generally present at elevated levels due to the presence of fill material on these properties.

- Pesticides, including aldrin and dieldrin, were found at several sampling locations at the Martin Aaron property, Comarco Products property, Everett Street, and Sixth Street. PCBs were detected above screening levels in surface soil samples collected from the Martin Aaron Site.

Subsurface Soil

- VOCs were only detected on the Martin Aaron property, and one upgradient location north of the property on Everett Street in subsurface soils. The VOCs detected most frequently included: TCE, PCE, cis-1,2-DCE, 1,1,1-trichloroethane (TCA), vinyl chloride, chlorobenzene, 1,1-DCE, methylene chloride, chloroform, 1,2,4-trichlorobenzene, benzene, and toluene. Benzene was the only VOC detected at the upgradient location in subsurface soils and was present at a relatively low concentration. The most commonly detected VOC in subsurface soils at the Martin Aaron property was PCE.

- SVOCs were identified above screening levels in subsurface soils at the Martin Aaron property, and sampling locations on Everett Street and Sixth Street. SVOCs detected most frequently in subsurface soils include: benzo(b)fluoranthene, benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, carbazole, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, n-nitrosodiphenylamine, isophorone, naphthalene, di-n-butyl phthalate, 3,3-dichlorobenzidine, chrysene and pyrene. There were no SVOCs detected above the screening criteria at Comarco, Ponte Company, or the scrap yard properties in subsurface soils.

- Metals were generally found in subsurface soils on all properties of the Site, and at most sampling locations. Metals above screening levels include: antimony, arsenic, barium, cadmium, chromium, lead, mercury, selenium and thallium.

- Pesticides were detected above screening levels in subsurface soil at the Martin Aaron property, Comarco Products property, and sampling locations on Everett Street and Jackson Street. In general, pesticide concentrations were relatively low. Beta-benzene hexachloride (BHC) and dieldrin were the pesticides identified most frequently. PCBs were detected above screening levels in subsurface soil samples collected at the Martin Aaron Site.

1.5.3 Groundwater Contamination

In the EPA RI, groundwater contamination was compared to the lower of the NJDEP "high value" and the EPA Maximum Contaminant Limit (MCL). The NJDEP "high value" is the greater of the GWQC and the Practical Quantitation Limit (PQL) for that compound. Below is a discussion of the nature and extent of groundwater contamination, by aquifer unit.

Surficial Upper PRM Aquifer. VOCs detected above screening levels within the Surficial Upper PRM Aquifer include: benzene, cis-1,2-DCE, TCE, 1,1-DCE, 1,2-dichloropropane, 1,2,4-trichlorobenzene, 1,1,1-trichloroethane, vinyl chloride (VC), xylene, 1,2-DCE, and PCE. SVOCs were detected at groundwater sampling locations within the Surficial Upper PRM Aquifer on the Martin Aaron property, Everett Street, and Sixth Street at concentrations above screening levels including n-nitrosodiphenylamine, phenol, and bis(2-chloroethyl)ether. Metals above screening levels include aluminum, antimony, arsenic, barium, cadmium, chromium, iron, lead, manganese, sodium, and thallium. Aldrin, dieldrin, and BHC were the most commonly detected pesticides.

Intermediate Upper PRM Aquifer. VOCs detected above screening levels within the Intermediate Upper PRM Aquifer include TCE, cis-1,2-DCE, VC, dichloropropane, and benzene. VOCs were primarily identified in groundwater samples collected from the Martin Aaron property. SVOCs were not detected above screening levels in any groundwater sample collected from the Intermediate Upper PRM Aquifer. Metals identified above screening levels in the Intermediate Upper PRM Aquifer are aluminum, antimony, arsenic, beryllium, cadmium, iron, manganese, sodium, and thallium. Pesticides and PCBs were not detected above screening levels in any groundwater sample collected from the Intermediate Upper PRM Aquifer.

Basal Upper PRM Aquifer. VOCs (TCE and vinyl chloride) were detected in all three of the regional groundwater sampling locations in the Basal Upper PRM Aquifer. SVOCs were not detected in any of the samples collected from the Basal Upper PRM Aquifer. Metals were detected in all three wells in the Basal Upper PRM Aquifer. The metals detected above screening levels include: aluminum, beryllium, iron, manganese, sodium, and thallium. Pesticides and PCBs were not detected in any of the samples collected from the Basal Upper PRM Aquifer.

Upper Middle PRM Aquifer. Three VOCs were detected in the deep aquifer above screening levels in the Upper Middle PRM Aquifer including TCE, cis-1,2-DCE, and vinyl chloride. SVOCs were not detected in any of the samples collected from the Upper Middle PRM Aquifer. Metals above screening levels in the Upper Middle PRM Aquifer are aluminum, beryllium, iron, lead, manganese, sodium, and thallium. Pesticides and PCBs were not detected in any of the samples collected from the Upper Middle PRM Aquifer.

1.6 Contaminant Fate and Transport

The primary constituents detected in the soil and groundwater that have a significant potential to migrate in the subsurface at the Martin Aaron Site are VOCs including: TCE, PCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, 1,1-DCA, 1,1,1-TCA, vinyl chloride and chloroethane. In addition, benzene, toluene, ethylbenzene, and xylene (BTEX) are also constituents of concern at the Martin Aaron Site. Other site-related chemicals of potential concern (COPCs) include the SVOCs, metals, PCBs, and pesticides. Since these COPCs tend to absorb to soils, they are more of a concern for transport via airborne migration or soil erosion rather than subsurface migration.

Historically VOCs and other constituents were introduced into the soil and groundwater from leaking and/or buried wastes during operations. Due to the presence of these sources, and the resulting contamination of the soil, constituents leach from the soil and are transported downward to the water table by infiltrating precipitation. Once in the Surficial Upper PRM Aquifer, the contaminants are transported both vertically and laterally, spreading outward and along the path of groundwater flow away from the original source areas. The predominant direction of contaminant migration in groundwater has been to the southeast.

Contaminants move vertically and laterally under the influence of the ambient hydraulic gradient upon reaching the water table in the Magothy Formation in the Upper PRM Aquifer. Contaminant concentrations in wells located southeast of the Martin Aaron property indicate that contamination has migrated approximately 400 feet beyond the property boundary in groundwater.

1.7 Summary of Human Health and Ecological Risks

1.7.1 Human Risk Characterization

The Human Health Risk Assessment (HHRA) (CH2M HILL, May 2004) evaluated the potential non-carcinogenic hazards and carcinogenic risks associated with potential exposures to surface soil, subsurface soil, and groundwater (from the Upper and Middle PRM Aquifers) for the Martin Aaron Site. Below is a summary of the HHRA completed for the Site, summarized by property.

Martin Aaron Property

Potential non-carcinogenic hazards and risks on the Martin Aaron property were identified above EPA target risk levels, mainly associated with metals (primarily arsenic, barium, chromium, iron, and mercury), PCB Aroclor 1254, and TCE. The potential carcinogenic hazards and risks above EPA target risk levels are associated with arsenic, TCE, and carcinogenic PAHs. Lead is also a potential health concern to fetuses of industrial workers and residential children.

Potential non-carcinogenic hazards and carcinogenic risks for current (adolescent trespassers and industrial workers) and future receptors (industrial workers, adult and child residents, and construction workers) exceed EPA target risk levels.

Active Scrap Yard Property

Potential non-carcinogenic hazards and risks above EPA target risk levels at the scrap yard are mainly associated with metals (primarily arsenic and barium). The potential carcinogenic hazards and risks that are above EPA target risk levels are associated with arsenic and benzo(a)pyrene. Lead is also a potential health concern to fetuses of industrial workers and residential children.

Potential non-carcinogenic hazards and carcinogenic risks for current (adult and child residents) and future receptors (adult and child residents and industrial workers) exceed EPA target risk levels. There is limited non-carcinogenic risk to future construction workers just above the EPA target Hazard Index (HI)=1 and carcinogenic risks were within the EPA target risk range.

Row Homes/Industrial Area

The potential non-carcinogenic hazards and risks that are above EPA target risk levels are mainly associated with metals (primarily arsenic and barium) and chlordane pesticides. The potential carcinogenic hazards and risks that are above EPA target risk levels are associated with arsenic and carcinogenic PAHs. Lead is also a potential health concern to residential children.

The potential non-carcinogenic hazards and carcinogenic risks for current (adult and child residents) and future receptors (adult and child residents and industrial workers) at the row homes/industrial area exceed EPA target risk levels. The potential non-carcinogenic risk to future construction workers is above the EPA target HI=1; however, potential carcinogenic risks were within the EPA target risk range.

Upper PRM Aquifer

The potential non-carcinogenic hazards and risks that are above EPA target risk levels within the Upper PRM Aquifer are mainly associated with metals (primarily arsenic and barium) and naphthalene, with additional smaller contributions from antimony, barium, iron, bis(2-chloroethylether), p-cresol, and benzene. The potential carcinogenic risks that are above EPA target risk levels are associated with arsenic, benzene, TCE, and vinyl chloride.

The potential non-carcinogenic risk for future receptors (adult and child residents, industrial worker, and construction workers) associated with potential exposure to the Upper PRM aquifer exceed the EPA target HI=1. The potential carcinogenic risk for future industrial workers and adult and child residents exceeded the EPA target risk range.

Middle PRM Aquifer

The potential non-carcinogenic hazards and risks that are above EPA target risk levels are mainly associated with iron and arsenic, with additional smaller contributions from manganese and thallium. The potential carcinogenic risks that are above EPA target risk levels are mainly associated with vinyl chloride, with additional smaller contributions from arsenic and TCE.

The potential non-carcinogenic risk for future receptors (adult and child residents, and construction workers) associated with potential exposure to the Middle PRM aquifer exceed the EPA target HI=1. The carcinogenic risk for future adult and child residents exceeded the EPA target risk range. There were no exceedances of EPA target risk range for future construction workers.

1.7.2 Ecological Risk Characterization

The Screening-Level Ecological Risk Assessment (SLERA) for the Martin Aaron Site (CH2M HILL (March 2004) summarizes the potential ecological risks associated with the investigation activities completed at the Site. The SLERA constitutes Step 1 (screening level problem formulation and effects evaluation) and Step 2 (exposure estimate and risk calculation) of the eight-step ERA process presented in *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA, 1997).

The SLERA results indicate the presence of COPCs in the Martin Aaron property surface soils. Potential risks were indicated to terrestrial plants and soil invertebrates from direct

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exposure to PAHs and inorganic chemicals in both areas, although inorganic chemical concentrations (and resulting potential risks) were generally higher in the Martin Aaron property soils. Several pesticides, PCBs, and VOCs were also identified as direct exposure COPCs in the Martin Aaron property soils.

Potential risks were indicated for terrestrial wildlife from inorganic chemicals, SVOCs, pesticides, and PCBs in the Martin Aaron property surface soils. However, many of these latter risks were based on doses estimated from exposure limits, and it is uncertain if these compounds are actually present in surface soil at concentrations that could represent a potential ecological risk.

The SLERA results suggested that several VOCs and inorganic chemicals in groundwater could represent a potential risk to ecological receptors if groundwater discharges to surface water. The SLERA also indicated the possible presence of several SVOCs, pesticides, and PCBs in groundwater. This was based on comparison of screening values to maximum reporting limits and it is uncertain if these chemicals were actually present in groundwater at concentrations that could represent a potential ecological risk. However, chemicals in groundwater could represent a potential risk to ecological receptors only if they discharge to a viable aquatic habitat. This pathway has not been established. Furthermore, the screening approach in the SLERA is highly conservative and does not account for the dilution and/or degradation that would occur prior to and immediately following discharge to surface-water bodies.

In conclusion, several COPCs were identified via direct exposure screening (surface soil and groundwater) and via food-web exposure modeling (surface soil) using the very conservative SLERA screening process.

2.0 Development and Identification of ARARs, RAOs, and PRGs

2.1 Summary of Applicable or Relevant and Appropriate Requirements

Remedial actions must be protective of public health and the environment. Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements, as well as to adequately protect public health and the environment.

Definitions of the ARARs and the "to be considered" (TBC) criteria are given below:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, environmental action, location, or other circumstance at a CERCLA site.
- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, which while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at a CERCLA site, that their use is well suited (appropriate) to the particular site.
- TBC criteria are nonpromulgated, non-enforceable guidelines or criteria that may be useful for developing an interim remedial action, or are necessary for evaluating what is protective to human health and/or the environment. Examples of TBC criteria include NJDEP Soil and Groundwater Cleanup Criteria, EPA Drinking Water Health Advisories, Reference Doses, and Cancer Slope Factors.

Another factor in determining which requirements must be addressed is whether the requirement is substantive or administrative. "Onsite" CERCLA response actions must comply with the substantive requirements but not with the administrative requirements of environmental laws and regulations as specified in the NCP, 40 CFR 300.5, definitions of ARARs and as discussed in 55 FR 8756. Substantive requirements are those pertaining directly to actions or conditions in the environment. Administrative requirements are mechanisms that facilitate the implementation of the substantive requirements of an environmental law or regulation. In general, administrative requirements prescribe methods and procedures (e.g., fees, permitting, inspection, reporting requirements) by which substantive requirements are made effective for the purposes of a particular environmental or public health program.

ARARs are grouped into three types: chemical-specific, location-specific, and action-specific. Included in Appendix A are the chemical-specific, action-specific, and location-specific ARARs for the Martin Aaron Site.

2.1.1 Chemical Specific ARARs

Chemical-specific ARARs include laws and requirements that establish health- or risk-based numerical values or methodologies for environmental contaminant concentrations or discharge. The chemical-specific ARARs for the Martin Aaron Site can be classified into two categories: (1) residual concentrations of compounds that can remain at the site without presenting a threat to human health and the environment; and (2) land disposal restriction (LDR) concentrations that must be achieved if the contaminated media that either is a characteristic hazardous waste or contains a listed hazardous waste is excavated or extracted and later land disposed. Effluent concentrations that must be achieved in treatment of groundwater for discharge to surface water are not considered in this evaluation since it is unlikely that discharge to surface water will be included in remedial alternatives. This is because a publicly owned treatment works (POTW) is available for discharge of treated groundwater. POTW pretreatment limits for compounds present in the groundwater will be considered during the detailed evaluation of alternatives.

Residual Concentrations

ARARs and TBCs for residual soil concentrations include the EPA Region 9 MCLs and the New Jersey Soil Cleanup Criteria (combined Tables 3-2 and 7-1 from the NJDEPs February 3, 1992 proposed rule titled Cleanup Standards for Contaminated Sites N.J.A.C. 7:26D), which includes the Residential Direct Contact Soil Cleanup Criteria (RDCSCC), the Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC), and the IGWSCC. For groundwater, Safe Drinking Water Act (SDWA) MCLs, the NJDEP GWQC (N.J.A.C. 7:9-6), and the New Jersey Secondary Drinking Water Standards (N.J.A.C. 7:10-7) are ARARs.

LDR Concentrations

The Resource Conservation and Recovery Act (RCRA) LDRs would apply to remedial actions performed at the Martin Aaron Site if waste generated by the remedial action (e.g., contaminated soil) contains a RCRA hazardous waste. Listed hazardous wastes are not known to have been disposed at the Martin Aaron Site. As a result excavated soils would not be required to be managed as listed hazardous wastes. If excavated and removed from the area of contamination (i.e. the soil is "generated"), the soil may be a characteristic hazardous waste, such as a D004 toxicity characteristic hazardous waste for arsenic.

Generated soils that exceed the Toxicity Characteristic Leaching Procedure (TCLP) limit must be managed as a hazardous waste and must meet the LDR Treatment Standards for contaminated soil (40CFR 268.49). The treatment standard for contaminated soil is the higher of a 90 percent reduction in constituent concentrations or 10 times the Universal Treatment Standards (UTS). Treatment is required for the constituent (such as arsenic) for which the soil is a characteristic hazardous waste as well as other "underlying hazardous constituents". Generators of contaminated soil can apply reasonable knowledge of the likely contaminants present to select constituents for monitoring (EPA, October 1998. *Management of Remediation Waste Under RCRA*, EPA530-F-98-026). Table 2-1 presents the UTS and the 10 times the UTS and the maximum measured concentration in soil for each selected COPC at the Martin Aaron Site. Based on the comparison of maximum measured concentration and 10 times the UTS, it appears that treatment will be necessary for arsenic (exceeding the TCLP limit of 5 mg/L) and potentially TCE at one specific location where concentrations were detected at 630 mg/kg.

2.1.2 Action Specific ARARs

Action-specific ARARs regulate the specific type of action or technology under consideration, or the management of regulated materials. The most important action-specific ARARs that may affect the RAOs and the development of remedial action alternatives are RCRA regulations. RCRA regulations governing the identification, management, treatment, storage, and disposal of solid and hazardous waste would be ARARs for alternatives that generate waste that would be moved to a location outside the area of contamination. Such alternatives could include excavation of materials (e.g., soil). Requirements include waste accumulation, record keeping, container storage, disposal, manifesting, transportation and disposal. As discussed above, portions of the soil at the Martin Aaron Site are expected to be characteristic hazardous waste. If the soil is characteristic hazardous waste, RCRA LDRs would apply and treatment would be required in accordance with RCRA prior to disposal. This includes treatment of other underlying hazardous constituents as required by 40 CFR 268.9(a). The primary LDR that would have to be met is the soil would have to be treated to the higher of 50 mg/L arsenic in the TCLP extract (i.e. 10 x the UTS of 5 mg/L) or a 90 percent reduction in hazardous constituent concentration prior to disposal in a RCRA Subtitle C Landfill. Alternatively the soil could be treated to below the TCLP limit of 5 mg/L, rendering it non-hazardous and disposed in a Subtitle D Landfill. Non-hazardous soil would be disposed in accordance with RCRA solid waste disposal requirements.

2.1.3 Location Specific ARARs

Location-specific ARARs are requirements that relate to the geographical position of the site. State and federal laws and regulations that apply to the protection of wetlands, construction in floodplains, and protection of endangered species in streams or rivers are examples of location-specific ARARs. The National Historic Preservation Act is considered an ARAR for this Site. Due to the Site's historical usage, and the Site location in an area generally sensitive for the discovery of prehistoric and historic cultural resources, a Stage 1A cultural resource survey may be performed at the Site. The Endangered Species Act (ESA) may also be considered as a location specific ARAR for this Site. Although previous consultation with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) have not resulted in specific recommendations from the Agencies, the ESA will be considered a potential ARAR until the remedy for the Site is chosen and a further determination can be made. Due to the location of the Site within the 100-year floodplain, Executive Order 11988 "Floodplain Management", 40 CFR Part 6, Appendix A and EPA's 1985 "Statement of Policy on Floodplains/Wetlands Assessments for CERCLA Actions" are also ARARs/TBCs for the Site. As such, a floodplain assessment will be required to design against the 100-year and 500-year flooding events, and a Statement of Findings will be documented in the Record of Decision (ROD).

2.2 Remedial Action Objectives

The EPA *Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites* (EPA, 1988a) and the NCP define RAOs as medium-specific or site-specific goals for protecting human health and the environment that are established on the basis of the nature and extent of the contamination, the resources that are currently and potentially threatened, and the potential for human and environmental exposure. Remediation goals are site-specific, quantitative goals that define the extent of cleanup required to achieve the RAOs. These goals are PRGs in the FS, and they will be finalized in the ROD for the Martin Aaron Site.

In this section, RAOs are developed for the media of concern at the Martin Aaron Site.

2.2.1 RAOs for Soil

There is a potential for exposure of contaminated soil by receptors (adult workers/excavation workers) that may present an unacceptable risk. The objective is to develop alternatives that will mitigate these risks to onsite receptors. In addition, contaminated soil at Martin Aaron Site is a source of contamination to groundwater. Consequently, an additional objective for remediating the contaminated soil is to allow the goals for groundwater remediation to be met.

The RAOs for soil at the Martin Aaron Site include:

- Prevention of human exposure, through contact, ingestion, or inhalation to contaminated soil that presents an unacceptable risk (i.e., hazard index [HI] greater than 1 or excess lifetime cancer risk (ELCR) greater than $1x10^{-4}$ to $1x10^{-6}$);
- Prevention of erosion and offsite transport of soils contaminated at concentrations posing unacceptable risk (i.e., HI greater than 1 or ELCR greater than $1x10^{-4}$ to $1x10^{-6}$); and
- Remediation of contaminated soils, as necessary, to prevent further leaching of contaminants to groundwater that result in groundwater in excess of MCLs, NJDEP IGWSCC, or NJDEP NRDCSCC (whichever is more stringent) or, for contaminants without primary SDWA MCLs, HI greater than 1 or ELCR greater than $1x10^{-4}$ to $1x10^{-6}$.

Prevent Human Exposure through Contact, Ingestion, or Inhalation. Exposure to contaminated soil through direct contact and ingestion is not likely to occur on the Martin Aaron property as currently sited since it is unoccupied and fenced. However, the Martin Aaron property may be redeveloped. Also, the results of the EPA RI demonstrate that contaminated soil exists on the properties surrounding the Martin Aaron property (the Comarco property, the scrap yard, and the Ponte Company property). This RAO is intended to prevent unacceptable risks to potential future industrial or excavation workers as a result of exposure to contaminated soils on each property within the Martin Aaron Site.

Prevent Erosion and Offsite Transport. Possible erosion of surficial soils could result in the offsite migration of COPCs at concentrations posing unacceptable risks through direct contact and ingestion. This RAO is intended to prevent unacceptable risks to offsite residents or workers as a result of exposure to contaminated soils.

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Remediate Contaminated Soils to Control Leaching. Soil analytical data indicate that subsurface soil at the Martin Aaron Site contains elevated concentrations of several metals and VOCs. Based on the results of the groundwater investigation, it is apparent that this contamination has leached to the groundwater and will likely continue to leach in the absence of site remediation. The amount of leaching should be controlled to the extent that it does not result in continued loadings to groundwater sufficient to cause further expansion of the groundwater plume, or result in an unreasonable time to remediate the groundwater.

2.2.2 RAOs for Groundwater

Although there are no groundwater receptors at the Martin Aaron Site, RAOs for groundwater are developed to minimize further migration of the contaminant plume and limit the time needed to remediate groundwater to below unacceptable risk levels.

The RAOs for remediation of groundwater at the Martin Aaron Site include the following:

- Remediate contamination in groundwater outside the soil source area (where contamination is continuing to leach to groundwater) to concentrations below MCLs and the NJDEP GWQC, or, in the absence of MCLs, HI=1 or ELCR of $1x10^{-4}$ to $1x10^{-6}$ within a reasonable time frame.
- Remediate groundwater within the soil source area (where contamination is continuing to leach to groundwater) to the extent practicable and minimize further migration of contaminants in groundwater.

Each of these RAOs is discussed in the following sections.

Remediate Contamination in Groundwater outside the Source Areas. Because the aquifer beneath the Martin Aaron Site is classified as a Class IIA aquifer (i.e., drinking water quality groundwater), it is necessary to reduce the mass of COPCs to meet MCLs and the New Jersey Drinking Water Quality Standards, or in the absence of MCLs, an ELCR of between $1x10^{-4}$ and $1x10^{-6}$, or HIs less than 1 outside the source areas.

There are currently no complete exposure pathways to contaminated groundwater beneath the Martin Aaron Site because there are no known contaminated wells in use. All residents in the area of the Martin Aaron Site are currently on city supplied water. If contaminated groundwater is used as drinking water in the future, significant health risks would exist. In addition, if the contaminated groundwater were used in industrial processes within the area, significant human health risks may exist due to the nature of the processes involved (e.g., if the Comarco facility were to use water for meat processes and packing). Thus, remedial actions must minimize the potential for human exposure to contaminated groundwater.

Remediate Groundwater within the Source Area to the Extent Practicable and Minimize Further Migration. Groundwater within the source area must be remediated to the extent practicable. However, the presence of contaminated soils and high concentrations in groundwater (specifically of arsenic), make it unlikely that groundwater can be returned to the MCLs or the New Jersey GWQC in the foreseeable future, even with active remediation. Further migration of contaminants to groundwater outside the source areas should be minimized to allow remediation of groundwater in a reasonable time frame. It should be noted that remediation of source area soils may occur depending on the preferred soil remedial alternative chosen. Remediation of source area soils may provide the possibility of further reduction of high groundwater concentrations.

2.3 Preliminary Remediation Goals

To meet the RAOs defined in Section 2.2., PRGs were developed to define the extent of contaminated media requiring remedial action. This section presents the PRGs and defines the volumes of affected media exceeding the PRGs that will be addressed in the FS process. In general, PRGs establish media-specific concentrations of contaminants of concern (COCs) that will pose no unacceptable risk to human health and the environment. COCs are the list of chemicals that result in unacceptable risk based on the results of the risk assessment. The PRGs are developed considering the following:

- PRGs representing concentration levels corresponding to an excess cancer risk between $1x10^{-4}$ and $1x10^{-6}$, a chronic health risk defined by a HI of 1, and/or a significant ecological risk. Given the lack of significant ecological habitat on the Martin Aaron Site, it is assumed that ecological PRGs will not be needed.
- Chemical-specific ARARs/TBCs including New Jersey Cleanup Criteria and Federal MCLs;
- Background concentrations of specific constituents; and
- Factors related to technical limitations, uncertainties, and other pertinent information.

A summary of the exposure pathways for soil and groundwater at the Martin Aaron Site are included in Table 2-2.

2.3.1 PRGs for Soil

Based on the potential future exposure risks and the RAOs presented in Section 2.2.1, soil PRGs were developed for onsite and offsite exposure, depending on current or proposed future use. The human health exposure pathways for the Martin Aaron property and the junkyard to the north of Martin Aaron were limited to industrial exposures because these areas are currently or are expected to remain industrial-use for the foreseeable future. For the area south of the Martin Aaron property that currently houses row homes, residential exposure pathways were used to develop the PRGs. For all areas, soil PRGs were developed for the ingestion, dermal, and inhalation human health exposure pathways.

Soil PRGs for each of the site COCs and for each of the above pathways are presented in Table 2-3. PRGs for the full risk range ($1x10^{-4}$ and $1x10^{-6}$ ELCR) based on the EPA Region 9 PRGs (Source: http://www.epa.gov/region09/waste/sfund/prg/index.htm) were used. Also included are the New Jersey Soil Cleanup Criteria (N.J.A.C. 7:7-1) for non-residential, residential land use direct contact, and protection of groundwater soil cleanup criteria. PRGs developed for protection from direct contact ingestion and inhalation exposures are applied to shallow soils (<2 feet depth) and subsurface soils from 2 to 10 feet depth, including areas consisting of historic fill. The soil PRGs protective of groundwater apply to all soils. The lowest PRG for the relevant exposure pathways is used where more than one PRG has been developed.

2.3.2 PRGs for Groundwater

PRGs were developed for groundwater based on the RAOs discussed earlier. The EPA Federal MCLs, the EPA Region 9 Tap Water (Source: http://www.epa.gov/region09/waste/sfund/prg/index.htm), and the NJDEP GWQC were compared to develop the groundwater PRGs. The PRGs for groundwater are listed in Table 2-4. EPA considers MCLs as the relevant PRG for Superfund sites as required by the NCP. However New Jersey considers its state set of GWQC to be the relevant PRG for remediation of groundwater. Where New Jersey GWQC are lower than the federal MCLs, the GWQC are used as the PRG.

2.4 Contaminated Media Exceeding PRGs

The areas and depths of soil and water that exceed the PRGs were developed by comparing results with the $1x10^{-4}$ ELCR, $1x10^{-6}$ ELCR and the applicable NJDEP cleanup criteria. Below is a discussion of the areas of soil and groundwater exceeding the PRGs.

2.4.1 Soil

The soil areas with concentrations exceeding the PRGs or risk-based standards were plotted for both surface soils and subsurface soils (including historic fill) at the Martin Aaron Site. Figure 2-1 illustrates the areas of VOC contamination over the $1x10^{-4}$ ELCR, HI=1, or the NJDEP PRG in both surface and subsurface soils. As seen from the figure, there is only one area with shallow soil contamination and three discrete areas of subsurface VOCs in soil over the PRGs, all within the Martin Aaron property. The surface soil area of contamination over the PRGs is west of the Rhodes Drum Building. The locations surrounding SO201 (east of the Rhodes Drum Building), SB11 (in the center of the Martin Aaron property), and SB47/SB31 (east of the Rhodes Drum Building and consistent with the area of the shallow soil contamination) are the subsurface areas exceeding the $1x10^{-4}$ PRGs. An evaluation of the soil areas with concentrations exceeding $1x10^{-6}$ ELCR or NJDEP PRGs (whichever is more stringent) was also completed (Figure 2-2). As shown in Figure 2-2, the areas did not extend to a much larger area than those in Figure 2-1.

Areas exceeding the $1x10^{-4}$ ELCR or NJDEP PRGs for SVOCs, PCBs, pesticides, and metals were also plotted in Figure 2-3 for surface and subsurface soils. The areas covered the Martin Aaron property and areas north of Everett Street and east of Sixth Street. Many of these areas are documented as being in a historic fill material area for the City of Camden (Figure 1-1A). The area between the Ponte building and the row houses to the south also exceeded the $1x10^{-4}$ ELCR in surface soils. As depicted in Figure 2-4, this evaluation was also completed for surface and subsurface soils that exceeded the more stringent of the $1x10^{-6}$ ELCR or NJDEP PRGs for SVOCs, PCBs, pesticides, and metals. This area is nearly the same in size as the $1x10^{-4}$ ELCR PRGs on the Martin Aaron property.

To determine if an area of arsenic soil contamination representing a principal threat to groundwater is present, an evaluation of arsenic soil concentrations versus Surficial Upper PRM groundwater was performed. Arsenic subsurface soil concentration contours are presented in Figure 2-5. The area of arsenic contaminated soil with concentrations over 300 mg/kg was found to most closely coincide with the area of elevated arsenic in the Surficial Upper PRM aquifer (see Figure 2-11). The area of arsenic exceeding 300 mg/kg is considered a "hot spot" of arsenic soil contamination.

It was found that the areas exceeding the $1x10^{-6}$ ELCR/NJDEP PRG and the $1x10^{-4}$ ELCR/NJDEP PRG are similar in size. Because the areas of surface and subsurface soils exceeding the PRGs are similar, it was assumed that all soil from 0-10 feet will be used to calculate soil volumes in the FS. Table 2-5 presents a summary of the areas and soil volumes exceeding PRGs. These areas are also summarized in Figure 2-6, which shows the soil areas over the PRGs for VOCs, SVOCs, pesticides, PCBs, and metals (from 0-10 feet) and the area where arsenic was detected over 300 mg/kg. Since VOCs may present a continuing leaching source to groundwater, the area where VOCs exceeded the $1x10^{-4}$ ELCR or NJDEP PRG is also separately included in Figure 2-6. It is important to note that because the arsenic and VOC-contaminated areas overlap in some places on the Martin Aaron property, the total area and volumes of combined contamination is less than the sum of the areas and volumes for the individual contamination.

2.4.2 Groundwater

The area exceeding PRGs is defined by the area over which concentrations of one or more contaminants exceed the PRGs for groundwater. Figures 2-7 though 2-9 document the areas exceeding the PRGs for the Surficial Upper PRM, the Middle Upper PRM, and the Basal Upper PRM Aquifers, respectively. As seen in the figures, the areas encompass the area immediately surrounding the Martin Aaron property and to the southeast. Based on this data, the contaminant distribution is within the same area over the Upper PRM aquifer, the area exceeding the PRGs within the Upper PRM Aquifer is depicted in Figure 2-10. The area encompassing approximately 8.7 acres is the area with VOCs (mainly chlorinated VOCs) exceeding the PRGs. Approximately 6.0 acres is the area with metals, PCBs, pesticides, or SVOCs over the PRGs. Because the concentrations of COPCs decrease with depth, it has been assumed that the representative area with contamination over the PRGs extends to approximately 50 feet bgs. The estimated volume of groundwater exceeding PRGs is approximately 43 million gallons (MG), assuming an effective porosity of 30 percent and an average saturated thickness of 50 feet.

Figure 2-11 depicts the isoconcentration gradients of arsenic exceeding the PRGs in groundwater at the Site. The area with the most elevated arsenic concentrations is considered to be the "hot spot", and covers an area of approximately 2.3 acres. Areas of arsenic contamination in groundwater outside of the hot spot, but within the area exceeding PRGs, will be addressed by other components of each groundwater remediation alternative.

3.0 Identification and Screening of Technologies

3.1 General Response Actions

Identifying general response actions is the first step in the FS alternatives analysis process; the general response actions are basic actions that might be undertaken to remediate a site. For each general response action, several possible remedial technologies may exist. They can be further broken down into a number of process options. These technologies and process options are then screened based on several criteria. Those technologies and process options remaining for the Martin Aaron Site after screening are assembled into alternatives in Section 4.0. After the RAOs and PRGs were developed, general response actions consistent with these objectives were identified. The following sections present general response actions that may be applicable to the Martin Aaron Site.

3.1.1 General Response Actions for Soil

The general response actions for soil at the Martin Aaron Site include:

- No further action;
- Institutional controls;
- Containment;
- In situ treatment; and
- Excavation/ex situ treatment/disposal.

Each general response action for soil is discussed in the following paragraphs along with an overview of some of the technologies that are representative of the response action.

No Further Action. The no further action response includes no action for soil except for what has already been implemented (i.e., removal of on-site process facilities and previous soil removal activities). The no action response action would not satisfy the RAO of eliminating contact to the contaminated soil or preventing erosion; therefore, this action is not feasible. The NCP requires that the no action alternative be retained through the FS process as a basis of comparison.

Institutional Controls. Institutional controls for soil consist of restricting access to contaminated soil through fencing or land use restrictions (such as Deed Notices). The Martin Aaron property is currently fenced to limit human contact to contaminated soil.

Containment. Containment is used to minimize the risk of contaminant migration as well as prevent direct contact exposures. Asphalt and soil capping are applicable remedial technologies that could be used to eliminate exposure to contaminated soils (including historic fill), limit the infiltration of precipitation and to help prevent contaminant migration offsite. Surface controls such as grading and revegetating can be used to reduce infiltration of precipitation through contaminated soil and prevent erosion and offsite transport of contaminated soil.

In Situ Treatment. In situ treatment methods can be used to reduce contaminant concentrations in soil and does not require removal of the impacted soil for treatment. In situ methods that may be applicable at the Martin Aaron Site include physical/chemical, biological, and thermal technologies. A wide variety of technologies are considered in screening, including soil vapor extraction (SVE), stabilization/solidification, and chemical oxidation/reduction. SVE involves the volatilization and removal of contaminants in soil via a vapor collection system. In situ stabilization/solidification involves chemical reactions that physically bind or reduce the mobility of inorganic contaminants. Chemical oxidation/reduction involves chemical reactions that convert hazardous contaminants to non-hazardous or less toxic compounds.

Excavation/Treatment/Disposal. Excavation involves removal of impacted soils (including historic fill) for either offsite or onsite disposal. Physical, chemical, or thermal treatment technologies are used once soil is excavated, as necessary. Physical processes include excavating the contaminated soil and transferring it to an approved onsite or offsite disposal area. Based on the concentration of contaminants present in the soil most likely to be excavated at the Martin Aaron Site, it is probable that the soil will require treatment to meet LDRs prior to disposal. Chemical processes such as stabilization, washing/flushing or thermal processes such as incineration to treat the soil to meet soil disposal criteria will be evaluated.

3.1.2 General Response Actions for Groundwater

The general response actions for groundwater at the Martin Aaron Site include:

- No further action;
- Institutional controls;
- Natural attenuation;
- Containment;
- In situ treatment; and
- Collection/treatment/discharge.

Each general response action for groundwater is discussed in the following paragraphs along with an overview of some of the technologies that are representative of the response action.

No Further Action. The no further action response includes no action for groundwater. As with the no further action alternative for soil, no action is retained through the FS process as a basis of comparison in accordance with the NCP. It has been presumed that the no further action response for groundwater will be coupled with the no further action option for soils as a basis of comparison.

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Institutional Controls. Institutional controls are restrictive covenants that eliminate potential future use of impacted groundwater. In New Jersey, the restrictive covenants are referred to as a Classification Exception Area (CEA). The CEA must include the area of impacted groundwater, the potential area of groundwater that may be impacted before completion of remedial actions, the contaminants and concentrations within the area, and an estimated duration of the CEA. Continued groundwater monitoring may also be necessary to track the direction and rate of movement of the groundwater contaminant plume as part of the institutional controls.

Natural Attenuation. Natural attenuation is the process by which contaminant concentrations are reduced by various naturally occurring physical, chemical, and biological processes. The main processes include dilution, biodegradation, and retardation. Only unaugmented natural processes are relied upon under this general response action. Augmentation through the in situ addition of electron acceptors or nutrients is considered under in situ biological treatment technologies.

Containment. Containment refers to minimizing the spread of groundwater contaminants through active or passive hydraulic gradient controls. Active gradient control can be accomplished with pumping wells, while passive gradient control can be achieved using a slurry or sheet-pile wall. Containment of groundwater can be effective in preventing the release of contaminants from the source areas and their subsequent migration.

In Situ Treatment. In situ treatment of groundwater entails treating the groundwater while it is in the aquifer, which can be achieved by applying physical/chemical, biological, or thermal techniques. Examples of possible approaches to in situ treatment include chemical oxidation, permeable treatment beds, air sparging, and biological treatment technologies.

Collection/Treatment/Discharge. In this response action, groundwater would be extracted from the shallow aquifer using pumping wells. The contaminants would then be removed from the water by physical, chemical, or biological treatment. Disposal of groundwater can be accomplished by surface infiltration, subsurface injection, discharge to surface water, or discharge to POTW.

3.2 Technology Screening Methodology

In this section, the technology types and process options available for remediation of soil and groundwater are presented and screened. Screening begins with development of an inventory of technology types and process options based on professional experience, published sources, computer databases, and other available documentation for the general response actions identified in Section 3.1.

The evaluation and screening of technology types and process options are presented in Tables 3-1 and 3-2 for soil and groundwater, respectively. Each technology type and process option is either a demonstrated, proven process, or a potential process that has undergone laboratory trials or bench-scale testing. The initial screening of technology types and process options is presented in the first half of the tables based on technical implementability. The factors in this evaluation include the following: the state of technology development, site conditions, waste characteristics, the nature and extent of contamination, and the presence of constituents that could limit the effectiveness of the technology. Entire technologies and individual process options are screened from further consideration based on technical implementability.

Process options that remain after the initial screening are further evaluated using a qualitative comparison based on effectiveness, implementability, and cost (presented in columns 6 through 8 of the tables). Following this qualitative screening, those remedial technology types and process options that are considered viable for remediating the media are carried forward for incorporation into alternatives. Those technology types and process options that are not technically implementable are shown in italicized and bolded text in the first half of the table. Those that are not considered feasible based on effectiveness, implementability, and cost are shown in italicized and bolded text in the second half of the table.

As mentioned above, technology types and process options are screened in an evaluation process based on effectiveness, implementability, and cost. Effectiveness is considered the ability of the process option to perform as part of a comprehensive remedial plan to meet RAOs under the conditions and limitations present. Additionally, the NCP defines effectiveness as the "degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risk, affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection." This is a relative measure for comparison of process options that perform the same or similar functions. Implementability refers to the relative degree of difficulty anticipated in implementing a particular process option under regulatory, technical, and schedule constraints posed at the site. At this point, the cost criterion is comparative only, and similar to the effectiveness criterion, it is used to preclude further evaluation of process options that are very costly if there are other choices that perform similar functions with similar effectiveness. The cost criterion includes costs of construction and any long-term costs to operate and maintain technologies that are part of an alternative.

The NCP preference is for solutions that utilize treatment technologies to permanently reduce the toxicity, mobility, or volume of hazardous substances. Available treatment processes are typically divided into three technology types: physical/chemical, biological, and thermal, which are applied in one or more general response actions with varying results.

The technology types and process options identified in the following sections are those offering at least theoretical applicability to remediation of the media of concern at the site. This list of options should be considered dynamic, flexible, and subject to revision based on further investigation findings, results of treatability studies, or technological developments.

3.3 Technology Screening for Soil Media

Table 3-1 presents a wide range of potentially applicable technology types and process options for soil remediation at the Martin Aaron Site. Screening comments are provided to highlight items of interest or concern for each option. This approach highlights differences within a remedial technology group to allow the best process within each group to be identified and selected.

Potentially feasible technologies and process options for each general response action for remediation of soil at the Martin Aaron Site are shown in plain text (i.e., not italicized or bolded) in Table 3-1. The response actions and associated technologies retained following screening include:

- No further action;
- Institutional controls (Land Use Restrictions);
- Containment by surface controls (grading and revegetation) and capping over the source areas (soil, pavement, or multimedia);
- In situ treatment by physical/chemical (stabilization and soil vapor extraction) and biological means (natural attenuation);
- Excavation of the soil followed by ex situ physical/chemical treatment (fixation/stabilization); and
- Disposal offsite (RCRA Subtitle C or D landfill).

The rationale for selecting these process options is indicated in Table 3-1. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options.

Containment. Under the containment response, surface controls such as grading and revegetation were retained because they are relatively inexpensive options and would effectively reduce infiltration through contaminated soil and historic fill while preventing direct contact exposure and erosion.

Asphalt pavement is retained as a capping technology due to potential future land use applications for the Martin Aaron Site, which is light industrial. An asphalt pavement cap would allow for the future use as a parking area. Soil caps were retained to allow for planting and landscaping during redevelopment. A combination of asphalt and soil covers will also be considered to allow for redevelopment with landscaped areas and paved parking areas.

In Situ Treatment. Several in situ treatment processes required more detailed evaluation to determine whether they should be retained. Due to the wide variety of compounds detected in soils and historic fill areas, many of the in situ treatment options were not retained. The in situ treatment processes that were retained are discussed in detail below and were in situ stabilization, vapor extraction, and natural attenuation.

In Situ Stabilization. In situ stabilization uses both physical and chemical means to reduce the mobility of contaminants in soil. The goal of this method is to trap the contaminants in the medium to prevent further migration and to allow for disposal. Common applications for this method include soils with inorganic contaminants such as metals (including historic fill). Application of this process includes the use of auger/caisson systems and/or high pressure injector heads.

In situ stabilization has several limitations. Contaminant depth can limit the effectiveness and some of the application processes. A potential for the stabilized material to weather and release into the environment also exists. Extensive pilot and leachability tests need to be conducted to verify the effectiveness of in situ stabilization. This process is effective with inorganics but not as effective for VOCs and SVOCs. The Martin Aaron Site has a complex mixture of contaminants including inorganics, SVOCs and VOCs. This method would be used primarily for arsenic contaminated soil and therefore, would need to be used in conjunction with other containment or treatment technologies for the remainder of the COCs exceeding PRGs.

Vapor Extraction. Vapor extraction involves the volatilization of soil contamination into the vapor phase for collection and treatment. The goal is to deliver clean air to the contaminated soil to strip out the contaminants for collection of vapors via a piping system. The advantage to using vapor extraction is that it provides permanent remediation of the treated soils.

There are also disadvantages to vapor extraction. Soils must be permeable and fairly homogeneous for effective removal. Short-circuiting to the ground surface can also occur, thus limiting the effectiveness of the technology. This process is highly effective for organic compounds, but is not effective for metals. Since the Martin Aaron Site has a complex mixture of contaminants including inorganics, SVOCs and VOCs, this method would therefore need to be used in conjunction with other containment or treatment technologies.

Natural Attenuation. Natural attenuation is the process by which contaminant concentrations are reduced by various naturally occurring physical, chemical, and biological processes. The main processes include dilution, biodegradation, and retardation. Only unaugmented natural processes are relied upon under this response action. Augmentation through addition of electron acceptors or nutrients is discussed under biological treatment technologies in the tables.

Ex Situ Treatment. As with the in situ treatment technologies, many of the ex situ treatment options were initially screened out due to the range of contaminants seen in soils (including historic fill). Based on the contaminants and concentrations seen in soil, the only ex situ treatment process that was retained was ex situ stabilization.

Stabilization. The same process as described in the previous section on In Situ Stabilization can be employed following excavation of the contaminated soil. Similar limitations can be expected for this method.

Disposal. After removal and any required treatment, the soils can be either backfilled onsite or disposed of offsite in an applicable landfill. Based on the concentration of arsenic present in the soil most likely to be excavated at the Martin Aaron Site, it is probable that the soil will not be able to be reused onsite and will require treatment to meet LDRs prior to disposal offsite.

3.4 Technology Screening for Groundwater Media

Using the same methodology described in the preceding section, Table 3-2 presents the results of a qualitative comparison of technology types and process options available for groundwater remediation at the Martin Aaron Site.

Potentially feasible technologies and process options for each general response action for remediation of groundwater at the site are shown in Table 3-2. The response actions and associated process options that were retained after screening for remediation of groundwater at the site include:

- No further action;
- Institutional controls (including access restrictions and continued groundwater monitoring);
- Monitored natural attenuation (MNA);
- Containment by hydraulic controls (groundwater collection via wells);
- Collection of groundwater (extraction wells);
- In situ treatment of groundwater by physical/chemical means (geochemical fixation);
- Ex situ treatment of contaminated groundwater by physical/chemical means (precipitation); and
- Discharge of treated water to the local POTW.

The rationale for selecting these process options is indicated in Table 3-2. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options. These technologies include MNA, containment, collection, ex situ treatment, and groundwater discharge.

Monitored Natural Attenuation. MNA is the process by which contaminant concentrations are reduced by various naturally occurring physical, chemical, and biological processes. The main processes include dilution, biodegradation, and retardation. Only unaugmented natural processes are relied upon under this general response action. Augmentation through addition of electron acceptors or nutrients is discussed under biological treatment technologies in the tables.

MNA is a viable technology for VOCs, but is less effective for SVOC and metals. Limitations such as limited supplies of nutrients or oxygen can also reduce the effectiveness of MNA.

Containment. Containment refers to minimizing the spread of groundwater contaminants through active or passive hydraulic gradient controls. This process option protects downgradient receptors and eliminates further migration of contaminated groundwater downgradient.

Active gradient controls can be accomplished with pumping wells at the Martin Aaron Site. Passive gradient controls such as slurry or sheet-pile walls are not effective at the Martin Aaron Site due to the depth of groundwater contamination. Limitations to containment and hydraulic control are that plume migration is relied upon for ultimate remediation (the plume must migrate to the downgradient collection point).

In Situ Treatment. In this response action, metals in groundwater are treated in situ by the addition of organic sulfur compounds, which stabilize the metals. The sulfur compounds react with the dissolved metals to form a complex which sorbs to the soil particles and immobilizes them.

This technology is effective for metals in groundwater, but is not effective for VOCs or SVOCs seen in groundwater. Additional treatment would be required for this technology to be effective to treat all COCs seen in groundwater at the Martin Aaron Site.

Collection. In this response action, groundwater is extracted from the shallow aquifer using pumping wells. The contaminants are then treated ex situ (as discussed in the following paragraphs) for ultimate disposal.

Active pumping options are effective for all contaminants seen in groundwater at the Martin Aaron Site and active pump and treat options are highly effective initially. However, this process option becomes much less effective with time, thus making it a much more costly process option.

Ex Situ Treatment. Several methods can be used for ex situ treatment of contaminated groundwater. Due to the complex mixture of contaminants that are present at the site, it is likely that a combination of technologies will need to be employed. The following technologies will be carried through for incorporation into alternatives as needed to meet discharge requirements.

Precipitation. This process transforms dissolved contaminants into an insoluble solid, removing the contaminant from the liquid phase and allowing for disposal. The process usually uses pH adjustment, addition of a chemical precipitant, and flocculation. This method is effective with groundwater contaminated with metals.

Several limitations exist including additional treatment, high costs, and complexity of inorganic mixtures. The process produces groundwater that likely requires pH adjustment and a sludge that potentially requires thickening along with treatment or disposal at a hazardous waste facility. Complex mixtures of metals in the groundwater may reduce the effectiveness of the process or require additional treatment methods.

Groundwater Discharge. Several groundwater discharge options are available for treated groundwater, such as injection of treated groundwater back into the unconfined aquifer, discharge to the POTW, and discharge to surface water. However, after review of the concentrations of compounds in groundwater (specifically arsenic) and the discharge requirements necessary, discharge to the POTW appears to be the only process option feasible for groundwater collected at the Martin Aaron Site.

Discharge to the POTW is a viable technology, but may require connection and discharge fees for the life of the remedial action. Also, additional monitoring requirements (such as Lower Explosive Limits [LEL], biological oxygen demand [BOD], and chemical oxygen demand [COD] limitations of permits may dictate discharge to the POTW.

4.0 Development of Alternatives

The remedial technologies and process options that remain after screening for soil and groundwater media at the Martin Aaron Site were assembled into a range of alternatives. The remedial alternatives have been developed separately for contaminated soil and groundwater media to allow for a wider range of alternatives and greater flexibility in selecting the recommended alternatives. However, there may be situations where alternatives for soil and groundwater are coupled for a higher degree of effectiveness.

The specific details of the remedial components discussed for each alternative are intended to serve as representative examples to allow order-of-magnitude cost estimates. Other viable process options within the same remedial technology that achieve the same objectives may be evaluated during remedial design activities for the site. The following sections provide a detailed description of each alternative.

4.1 Development of Soil Media Remedial Alternatives

Six soil media alternatives were developed to create a range of remedial actions and include all the remaining technologies into at least one alternative. Table 4-1 presents a matrix of technologies that remained after initial screening and the alternatives into which they were incorporated.

Soil Media Alternative 1–No Further Action. The objective of Soil Media Alternative 1 (S1), the No Further Action Alternative, is to provide a baseline for evaluation of remedial alternatives, as required by the NCP. Under this alternative there would be no additional remedial actions conducted at the Martin Aaron Site to control or remove the VOC, SVOC, pesticide, PCB and metals contamination. It is expected that arsenic and VOCs would continue to impact groundwater. There would be a risk from direct contact with the soil if the Martin Aaron Site was developed in the future for industrial use if no further actions were taken.

Soil Media Alternative 2–Cap and Institutional Controls. Under Soil Media Alternative 2 (S2), the areas of contaminated soil (including historic fill areas) exceeding the PRGs for VOCs, SVOCs, PCBs, pesticides, arsenic, and metals on the Martin Aaron property would be covered with an asphalt cap. Figure 4-1 presents the conceptual layout of the asphalt and soil cap. The soil remedial objectives are met by the S2 alternative through prevention of direct contact to impacted soils, preventing continued erosion of contaminated soils and minimizing leaching to groundwater. The main components of this alternative are:

- Land Use Restrictions
- Building Demolition
- Grading
- Asphalt Cap

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These components for Alternative S2 are discussed below.

Land Use Restrictions. Since it is possible that re-use of the capped properties may occur, institutional controls will be placed on the Site. Institutional controls would consist of land use restrictions for the areas below the soil covers. A restrictive covenant would be placed on the deed of the Martin Aaron property identifying: (1) the areas of soil with contamination of VOCs, SVOCs, and metals over the PRGs, and (2) the areas with site-specific engineering controls. The Martin Aaron property would also have a requirement for VOC vapor controls for buildings constructed on the property. The Deed Notice would be prepared in accordance with the NJDEP Technical Requirements for Site Remediation N.J.A.C. 7:26E, specifically Section 8.2, Appendix E. Also, as part of the land restriction, biennial certifications will be submitted each two years while the engineering and institutional controls are in place. The biennial certifications include inspections of the site to verify the integrity of the engineering controls, determine if any disturbances have occurred to the controls, and verify that the engineering controls are still protective of public health and the environment.

Building Demolition. Demolition of the existing Rhodes Drum Building on the Martin Aaron property will be conducted as part of this alternative because soil contamination extends up to the building walls and may extend beneath the building. In addition, the Rhodes Drum Building was determined to be structurally unsafe during the EPA RI. Poor structural stability would result in unsafe working conditions during construction activities. The proposed cap would be potentially incomplete and not protective if the Rhodes Drum Building foundation is not under a common cap. Upon completion of building demolition, a 12-inch cap will be installed on the former building footprint. A 12-inch cap is assumed for construction over the remaining building foundations as well. Asbestos and lead based paints may be of concern in the building, which may increase demolition costs. Also, additional costs may be incurred due to the poor structural integrity of the building. Demolished buildings would be disposed of in a nearby solid waste landfill or salvaged as deemed appropriate by the demolition contractor. Debris such as concrete that may contain arsenic or lead would be tested for TCLP metals, and would be disposed of appropriately based on the profile.

Grading. The current elevation of the Martin Aaron property is generally flat. However, there are drainage problems and areas where water ponds after rain events. Prior to the installation of the cap, the area would be regraded using fill material (either regraded material from the area or limited clean fill from offsite) to allow for proper drainage after installation of the cap

Asphalt Cap. An asphalt cap would be placed over the impacted areas on the Martin Aaron property, as designated in Figure 4-1. The asphalt cap system will involve two separate asphalt caps, over a gravel sub base for stability. The first will be a 12-inch cap over those areas with VOCs exceeding 10^{-4} ELCR or NJDEP PRGs and arsenic greater than 300 mg/kg in (0-10 feet below ground surface [bgs]). This cap includes two 4-inch low permeability asphalt layers separated by a 4-inch permeable leak detection layer. General cross-sections of the caps are illustrated in Figure 4-2. The objective of this cap is to prevent direct contact, erosion and minimize infiltration in the areas where leaching is of greatest concern. The second cap will be a 4-inch low permeability asphalt cover over those areas that exceed 10^{-6}.

ELCR or NJDEP PRGs (0-10 feet bgs), including the soils with arsenic contamination outside of the "hot spots". The primary objectives of this cap are to prevent direct contact and erosion. Leaching will also be reduced, though in these areas leaching is not believed to be occurring at significant levels. The general cross sections of the asphalt caps used in costing this alternative are included in Figure 4-2. Final cap cross sections would be determined during remedial design.

Erosion control after placement of the asphalt caps will involve controlling surface water runoff such that the volume and velocity of overland flow is reduced to a level that will not result in erosion of surface soils. It is anticipated that surface water runoff over the Martin Aaron Site will be toward Broadway Avenue, for eventual collection by the storm sewer system.

Cost Estimate Assumptions

- One percent of both the 12-inch and 4-inch cap areas will need to be repaired on an annual basis.
- Approximately thirty percent of both the 12-inch and 4-inch cap areas will need to be repaired at year 30.
- For the 12-inch cap area, approximately one half foot of material will be excavated for grading purposes and this material will expand by approximately 30 percent.
- For the Rhodes Building demolition, the demolition material is non-hazardous, e.g., no significant asbestos, lead or PCBs are present.

Soil Media Alternative 3— Cap, Soil Vapor Extraction and In Situ Stabilization. Soil Media Alternative 3 (S3) meets the RAOs by (1) implementing in situ SVE for the grossly contaminated soil mass, (2) in situ stabilization of the soil with concentrations of arsenic over 300 mg/kg, and (3) placing a 4-inch asphalt cap (similar to that under Alternative 2) over the remainder, as well as the treated areas, of the impacted soils. The volume of soil containing VOCs to be treated in situ with SVE is approximately 12,150 CY and the volume of soil containing arsenic to be stabilized in situ is approximately 16,000 CY. Figure 4-3 presents the approximate locations for the SVE system and the area where in situ stabilization will be performed. The total cap area is anticipated to be the same area as presented in Alternative S2 and depicted in Figure 4-1.

The main components of alternative S3 include:

- Land Use Restrictions
- Building Demolition
- Grading
- Asphalt Cap
- In Situ Stabilization
- In Situ SVE

The land use restrictions, building demolition, grading, and asphalt cap will be the same as described for Alternative S2 with the exception that the cap thickness will be 4-inch only since the treated areas will not require the same level of leaching protection as that of Alternative S2. The asphalt cap will be located within the area of soil cover defined in Alternative S2 and will also be used as a vapor barrier during SVE. The cap will be installed after the installation of the SVE system and completion of the in situ stabilization.

The other components of soil alternative S3 are discussed below.

In Situ Stabilization. The area of arsenic contaminated soil with concentrations over 300 mg/kg will be targeted for in situ stabilization. This area was chosen based on an evaluation of the area of arsenic soil contamination contributing to the arsenic groundwater plume in the Surficial Upper PRM groundwater (see Section 2.4 Contaminated Media Exceeding PRGs). For cost estimating purposes an area of 43,000 square feet was assumed to a depth of 10 ft resulting in an in situ volume of 16,000 CY. Soils containing arsenic concentrations below 300 mg/kg will be covered with the proposed 4-inch asphalt cap, as described above. As part of pre-design activities, a leachability study and additional soil arsenic delineation will be completed to determine if this area is adequate for eliminating the source area to groundwater. Although the exact mixture of stabilization materials will be determined during a treatability test, it has been assumed that a concrete mixture will be used for stabilization. The soils will be mixed in situ via mixing cells. In order to control potential volatilization of the VOCs from the heating of the soils during stabilization, the following measures will be considered for implementation: periodic application of water or emission controlling foams to the surface soils during stabilization, use of portable surface covers, and conducting air monitoring throughout the area being stabilized. The type of emission control to be used will be determined during pre-design studies. A brief discussion of the mixing cells is provided below.

After creating the mixing cell by removing a small area of soil adjacent to the excavation area, material from an adjacent cell will be placed into the mixing cell and stabilization reagents will be added and mixed using the excavation equipment. The in-situ mixing/handing process will be completed laterally across each area (thus creating a "rolling" cell) until one "lift" has been stabilized in-situ. After the material has been moved and stabilized in the adjacent cell, the extent of each cell will be marked in the field to document the extent and volume of stabilized soil in each surface cell. After stabilization has been completed, the asphalt cap will be placed over the area. It is assumed that up to a 20% increase in volume of the soils may occur due to the stabilization. It is assumed that the in-situ stabilization of arsenic contaminated soils will occur prior to the installation of the in-situ SVE system. This assumption will be verified during pre-design studies.

In Situ SVE. The area with concentrations of VOCs over the 1×10^{-4} ECLR or NJDEP PRGs in soils will be targeted for in situ SVE treatment. This is also the area that has the greatest potential to serve as a continuing source of VOCs to groundwater. The areas for SVE treatment are shown on Figure 4-3. The system will consist of a series of air extraction wells that will collect vapors generated from the volatilization of VOCs in soils. Because the VOC contaminated soils are relatively shallow, the area will be capped and shallow air inlet wells will be installed to allow better control of air flow.

A general layout of the in situ SVE system is depicted in Figure 4-4. The system consists of a series of extraction wells that are first connected to a water/condensate knock-out tank that removes any liquid extracted by the system. It is assumed that air emissions will require treatment prior to discharge. If so, the air is then passed through vapor-phase granular activated carbon (GAC) which adsorbs the contaminants to the carbon media. Or, during start up, a catalytic oxidation unit may be used if the initial VOC concentrations are such that the GAC system would not be cost efficient to run. As a note, it has been assumed that the system would be installed as a below-ground system immediately prior to installation of the asphalt cap within this alternative. This will minimize short-circuiting of air from the ground surface and allow for redevelopment while the system is operating.

Cost Estimate Assumptions

- No soil fracturing is required for the SVE implementation. Soil borings from the EPA RI indicate that a consistent clay layer does not exist until 10" bgs.
- The in situ stabilization area will incorporate the > 300 ppm arsenic area. See Figure 4-2.
- For in situ stabilization, a minimum of 500 CY of soil will be treated per day.
- The ratio of soil to cement to is 5:1 for in situ stabilization
- The in situ mixing depth will be approximately 10'.
- The SVE radius of influence will be approximately 50', and inflow wells will be spaced appropriately at 2' of depth.
- The trenching for the SVE system will have native pipe bedding/backfill material available.
- Due to the initial high VOC loading expected, a temporary catalytic oxidation unit will be used until VOC levels are such that the GAC system can be implemented.

Soil Media Alternative 4- Cap, Excavation, Treatment and Offsite Disposal. Soil Media Alternative 4 (S4) includes excavation of the VOC impacted soils over the $1x10^{-4}$ ELCR or NJDEP PRGs and arsenic impacted soils over 300 mg/kg (approximately 28,000 CY of impacted soil), treatment (as necessary) and offsite disposal at a Subtitle C or D landfill. The excavation areas are the areas depicted in Figure 4-5. The unexcavated portions of the Martin Aaron Site exceeding PRGs would be capped as presented in Alternative 3. Additionally, excavated and backfilled areas would be capped as well. This alternative meets the remedial objectives by removing highly contaminated soils that are continuing to leach VOCs and arsenic to groundwater and eliminates contact with the remaining soil contamination by the cap. Treatment of the soil prior to disposal will be used to meet the LDRs and allow for disposal at a Subtitle D landfill as non-hazardous waste. If treated arsenic soils do not meet the disposal requirements of the Subtitle D landfill, the treated arsenic soils will be disposed of at a Subtitle C, hazardous waste landfill.

The major remedial components of Alternative S4 are the following:

- Land Use Restrictions
- Building Demolition
- Grading
- Asphalt Cap
- Excavation
- Ex Situ Stabilization
- Offsite Disposal at Subtitle C or D Landfill

The land use restrictions, building demolition, grading, and cap for Alternative S4 are the same as that presented for Alternative S3.

Excavation. The excavation within the VOC impacted soils over the $1x10^{-4}$ ELCR or NJDEP PRGs and arsenic impacted soils over 300 mg/kg will be completed using standard equipment (backhoes, front-end loaders, etc.) to an approximate depth of 10 feet. Soils containing arsenic concentrations below 300 mg/kg will be covered with the proposed 4-inch asphalt cap, as described above. Based on the depths of the excavation, it is not anticipated that stabilization of the excavation footprint will be necessary. The excavation will be sloped (assumed to be a 2:1 sloping) during the excavation with the exception of the area south of the Ponte Company warehouse building, where building reinforcement will be needed.

A certified waste hauler (either a hazardous or non-hazardous waste hauler, depending on the characterization of the soil) will be used to transport the soil offsite. All waste will be labeled and shipped in accordance with U.S. Department of Transportation (DOT) regulations. Manifests will accompany waste materials leaving the Martin Aaron Site.

Temporary stormwater diversion and soil erosion and sediment control measures will be established prior to excavation. As necessary, staging areas will be created to allow for temporary stockpiling of soils during excavation. The areas will be bermed and lined in accordance with the stormwater control measures. It is anticipated that a site-specific air permit (which will include air monitoring during the excavation) will also be required.

The excavation areas will be backfilled with clean-certified fill material. The backfill will be similar in properties (porosity, grain-size) as the native material. The backfilled material will be compacted in lifts to the ground surface.

Ex Situ Stabilization. Based on the elevated arsenic concentrations seen in soil and the presence of arsenic in groundwater, it has been assumed that the arsenic in soil is leachable and will be characteristically hazardous for 50% of the excavated arsenic soil. Therefore, prior to disposal, it is assumed for cost estimating purposes that 50% of the excavated soils will be stabilized to bind the metals to the soil matrix, thus reducing the leachability of the metals to below TCLP limits. The process for ex situ stabilization is similar to the in situ methods discussed in Alternative S3, however, this will be completed at an offsite treatment facility.

After treatment, the soils will be analyzed to verify that it is non hazardous using the TCLP test.

Offsite Disposal. The excavated VOC contaminated soils and the stabilized arsenic contaminated soils will be disposed at either a Subtitle D or C landfill. If the treated arsenic soils do not meet the requirements of the Subtitle D landfill, they will be transported via a hazardous waste carrier and disposed of at a Subtitle C landfill. It is not anticipated that the VOC contaminated soils will be a characteristic hazardous waste or otherwise require treatment to meet LDRs prior to disposal, with the exception of TCE at one isolated location. Discrete confirmatory sampling will be conducted to determine actual volumes of soil as well as potential hazardous waste characteristics. The actual facility where the soils will be disposed of will be based on costs and performance reviews.

Cost Estimate Assumptions

- Excavated material will expand by approximately 30 percent.
- None of the VOC soil will require treatment prior to disposal in a Subtitle D landfill.
- 50 percent of arsenic soil will require stabilization prior to disposal in a Subtitle C or D landfill.50 percent of arsenic soil will not require treatment prior to disposal in a Subtitle D landfill
- Ex situ stabilization will require a soil to cement ratio of 5:1.

Soil Media Alternative 5— Cap, In Situ Soil Vapor Extraction, Excavation, Treatment and Offsite Disposal. Soil Media Alternative 5 (S5) meets the RAOs by: (1) performing in situ SVE of the VOC impacted soils with concentrations over $1x10^{-4}$ ELCR or NJDEP PRGs; (2) excavation of the arsenic impacted soils over 300 mg/kg, along with ex situ treatment of excavated soils and offsite disposal at a Subtitle C or D landfill; and (3) placing a cover over the remaining areas exceeding PRGs (including the soils containing arsenic concentrations below 300 mg/kg). The locations of the excavation, SVE system, and cap are depicted in Figure 4-6. This alternative meets the remedial objectives by treating the areas with soil contamination that are continuing sources to groundwater and eliminating contact with the remaining contamination by the cap.

The major remedial components of Alternative S5 are the following:

- Land Use Restrictions
- Building Demolition
- Grading
- Asphalt Cap
- In Situ SVE
- Excavation
- Ex Situ Stabilization
- Offsite Disposal at Subtitle C or D Landfill

All of the remedial components for S5 are the same as that presented for Alternatives S2, S3, and S4.

Soil Media Alternative 6- Total Excavation, Treatment and Offsite Disposal. The objectives of Soil Media Alternative 6 (S6) is removal of all soils over the $1x10^{-6}$ ELCR or NJDEP PRGs. The depth of excavation varies from 2 feet to a maximum depth of ten feet. The soils will be treated, as necessary, and disposed of offsite at a Subtitle C or D landfill. Clean backfill material will be placed into the excavations for regrading and future site redevelopment. This option will allow for unrestricted future use of the properties and will not require land restrictions or limit development options.

The major remedial components of Alternative S4 are the following:

- Building Demolition
- Excavation
- Ex Situ Stabilization
- Offsite Disposal at Subtitle C or D Landfill

The building demolition, ex situ stabilization, and offsite disposal for S6 are the same as that presented for soil media Alternative S5. Below is a discussion of the excavation to be completed as part of this alternative.

Excavation. The excavation of soils with concentrations of COCs over the PRGs will be completed as discussed above using standard equipment (backhoes, front-end loaders, etc.) to an approximate depth of 10 or 2 feet as applicable. The area of excavation (as depicted in Figure 4-7) will encompass a majority of the Martin Aaron property, resulting in excavation of approximately 64,500 CY. Backfill will consist of clean, certified material and would be compacted and graded as discussed in Alternative S4. The stormwater, soil erosion and sediment control measures, and applicable permits discussed in Alternative S4 will also be required for this alternative.

4.2 Development of Groundwater Media Remedial Alternatives

Five groundwater media alternatives were developed to provide a range of remedial actions for groundwater contamination at the Martin Aaron Site. They combine all the remaining technologies into at least one alternative. Table 4-2 presents a matrix of technologies that survived screening and the alternatives into which they were incorporated. The following sections detail each of these alternatives.

4.2.1 Description of Alternatives

The remedial action objectives for the groundwater alternatives are:

- Remediation of groundwater within areas where contamination is continuing to leach to groundwater to the extent practicable and minimize further migration of contaminants in groundwater;
- Prevention of human ingestion of contaminated groundwater that presents an unacceptable risk (i.e., MCLs, or in the absence of MCLs, to a HI greater than 1, or ELCR greater than $1x10^{-4}$ to $1x10^{-6}$); and
- Restoration of the groundwater aquifer to drinking water quality in a reasonable timeframe.

Below is a summary of each of the groundwater media alternatives for areas exceeding PRGs.

Groundwater Alternative 1—No Further Action. The objective of the groundwater media Alternative 1 (G1) is to provide a baseline for comparison to other alternatives, as required by the NCP. Alternative G1 does not include any further remedial action for groundwater. It does not include monitoring or institutional controls. Because it serves as a baseline, it is assumed that this alternative would be paired with the soil media Alternative 1—No Further Action. It is estimated that more than 50 years will be required to achieve MCLs if this alternative is chosen (assuming natural attenuation of the groundwater will occur).

Groundwater Alternative 2— MNA and Institutional Controls. The objective of Groundwater Alternative 2 (G2) is to rely on natural attenuation of the groundwater plume while placing use restrictions on the area of groundwater exceeding PRGs until groundwater returns naturally to below standards. If monitoring data indicate further spreading of the plume above remedial goals, active restoration with one of the remaining alternatives (G3, G4, or G5) would be implemented. This alternative will be paired with soil remedial alternatives that either treat or remove the soil with the highest COC concentrations so that further mass flux to the plume would be minimal, thus decreasing substantially the time until natural attenuation achieves the remedial goals. Removal or treatment of the soil source areas, would aid in the natural attenuation process. Remediation of groundwater in the soils source area would be achieved in a shorter time frame since continued leaching of contaminants to groundwater would be prevented by removal or treatment of source area soils; remediation of groundwater outside the soil source area to concentrations below the PRGs would be achieved eventually through natural flushing. An additional five monitoring wells are estimated to be installed as part of this alternative to further define the extent of the plume and to provide additional monitoring locations.

The main remedial components of G2 are:

- Groundwater Use Restrictions
- Monitored Natural Attenuation

Groundwater Use Restrictions. Institutional controls, in accordance with the NJDEP regulations (N.J.A.C. 7:26E-8.3) are designated as a Classification Exception Area (CEA). The components of the CEA include the location of the restriction (which includes the potential migration locations before degradation reduces to below applicable cleanup criteria), the compounds detected over the applicable cleanup criteria within the restricted area, and the proposed duration of the restriction. This control will eliminate future use of the groundwater within this area and will restrict the installation of wells over the duration of the CEA. The CEA will be submitted and approved by the NJDEP and placed within the New Jersey GIS database for the duration of the control. Pursuant to N.J.A.C. 7:9-6.6(d) restrictions will be required on potable groundwater uses within a CEA where there is or will be an exceedance of the Primary Drinking Water Standards (N.J.A.C. 7:10). If contaminant levels within the CEA exceed the MCL and the designated aquifer use based on classification includes potable use, NJDEP will identify the CEA as a Well Restriction Area (WRA).

Monitored Natural Attenuation. Natural attenuation is the process by which contaminant concentrations are reduced by volatilization, dispersion, adsorption, and biodegradation. The VOC groundwater contamination is most amenable to natural attenuation. The main mechanisms of VOC attenuation are expected to be volatilization and biodegradation. There is evidence of biological reductive dechlorination of the CVOCs because of the presence of the degradation products cis 1,2-DCE and vinyl chloride.

Natural attenuation mechanisms for metals such as arsenic are much more limited because they are elements that do not degrade. However arsenic in groundwater is present in the more soluble reduced species. The arsenic would be expected to precipitate onto the aquifer matrix over time as the shallow upper RPM aquifer slowly returns to aerobic oxidizing conditions. The time for this to occur is dependent on the rate of oxygen and transfer to the shallow aquifer and the degree to which the oxygen will be utilized by microorganisms present in the aquifer to degrade organic substrates. The time needed for this to occur can be estimated based on natural attenuation data collected as part of this alternative.

Environmental monitoring will be used to assess the degree of natural attenuation and allow estimates of the time necessary to reach remedial goals. Based on NJDEP requirements, it has been assumed that monitoring will be necessary for two consecutive years following achievement of the remedial goals, on a quarterly basis. Monitoring will be conducted on an annual basis for succeeding years. The monitoring wells that will be used to verify MNA will be MW-1S, MW-5S, the MW-14 well cluster, the MW-15 well cluster, the MW-13 well cluster (all within the extent of the plume), the MW-18 well cluster, the MW-19 well cluster (upgradient locations), and the MW-20 and MW-11 well clusters (downgradient). Groundwater samples will be analyzed for VOCs, metals, nitrate, sulfate, hydrogen sulfide, methane, ethane, ethene, BOC, COD, TOC and the field parameters (oxygen, ORP, temperature, turbidity and pH).

Groundwater Alternative 3 - Containment with Hydraulic Controls. The objective of Groundwater Media Alternative 3 (G3) is to intercept the contaminated groundwater using a series of extraction wells along the downgradient edge of the plume extent and to collect groundwater from within the high arsenic concentration portion of the plume to reduce contaminant migration. The system will pump at a low flow rate, and is used primarily as a protective measure for downgradient groundwater quality. This alternative will meet the remedial objectives by preventing downgradient migration of the plume and protection of any receptors and eventual treatment of the plume ex situ. This alternative will be paired with soil remedial alternatives that either treat or remove the soil with the highest COC concentrations so that further mass flux to the plume would be minimal, thus decreasing substantially the time until natural attenuation achieves the remedial goals. Removal or treatment of the soil source areas would aid in the natural attenuation process. Remediation of groundwater in the soils source area would be achieved in a short time frame since continued leaching of contaminants to groundwater would be prevented by removal or treatment of source area soils and areas of elevated groundwater concentrations would be collected and treated; remediation of the groundwater outside the soil source area to concentrations below the PRGs would be achieved eventually through a combination of natural flushing and collection of groundwater at the downgradient perimeter.

The main remedial components of G3 are:

- Groundwater Use Restrictions
- Monitoring of Groundwater
- Containment with Hydraulic Controls
- Chemical Precipitation Treatment
- Discharge to POTW

The groundwater use restrictions are as described for Alternative G2.

Monitoring of Groundwater. During active pumping of the plume, groundwater quality upgradient, within, and downgradient of the plume extents will be monitored. This will be accomplished by continued sampling of the MW-14, MW-15, MW-13 well clusters (all within the extent of the plume), the MW-18 and MW-19 well clusters (upgradient locations), and the MW-20 and MW-11 well clusters (downgradient). An additional five monitoring wells are estimated to be installed as part of this alternative to further define the extent of the plume and to provide monitoring locations.

Note that as part of the CEA for groundwater, monitoring will be required to verify that the plume extent does not extend further than the restriction area. The monitoring requirements will be incorporated within the CEA for inclusion to the state of New Jersey.

Containment with Hydraulic Controls. The objective of this component is to collect the downgradient edge and a portion of the "hot spot" areas of the plume, and allow for natural migration of the remainder of the plume for eventual collection by the downgradient system. The groundwater extraction treatment system will consist of extraction wells, extraction pumps and discharge to the POTW. Based on the contaminants seen in groundwater, the vertical extent of the contamination extends to approximately 125 feet bgs. However, the bulk of the contamination is within 50 feet of the ground surface. Therefore, it has been assumed that the active pumping will be to a depth of approximately 50 feet.

Although details of the pumping rates will be determined during pre-design activities and during site pump tests, it has been initially calculated that 3 extraction wells along the downgradient edge of the plume will pump at a combined 45 gallons per minute (gpm). Additional extraction wells will be installed within the area of elevated groundwater concentrations to extract heavily contaminated groundwater to reduce the time until PRGs are met. Residual groundwater concentrations which exceed PRGs for groundwater, will be captured by the downgradient system. The number of wells and flow rate will be set during design to maximize extraction within the area of elevated groundwater concentrations. Based on preliminary evaluations it is estimated that 2 extraction wells pumping at a combined flow rate of 20 gpm would be used. The general locations of the pumping wells for this alternative are illustrated on Figure 4-8. Groundwater concentrations outside of the hot spot areas will be captured by the downgradient system.

The extraction pumps will be submersible pumps. Contaminant concentrations were estimated for the collection system discharge and compared against the Camden County Municipal Utilities Authority (CCMUA) POTW pretreatment limits. Estimated concentrations were developed from the most recent RI sampling data or from the maximum concentrations measured in a specific monitoring well over time. None of the contaminants exceed the limits, thus potentially allowing for direct discharge to the POTW sewer system without pretreatment. However, chemical pretreatment is included in this alternative prior to discharge to the POTW because of uncertainty over potential influent arsenic concentrations and pretreatment requirements. See Table 4-3 for expected contaminant values and POTW limits. All of the VOCs detected in groundwater at the Site are below the CCMUA limits. Based on regional groundwater data, there is the possibility that radionuclides may be present in groundwater due to historical use within the Camden area. At this time, it is not known if any radionuclides above any NJDEP limits are present in the groundwater at the Martin Aaron Site. Samples will be taken and analyzed for specific radionuclides and, if necessary, a treatment system such as filtration/ion exchange will be added. For costing purposes, it has been assumed that these treatment components will not be necessary. It has also been assumed that the system would operate for 20 years to reduce concentrations to levels acceptable to those to be remediated through natural attenuation.

Chemical Precipitation. Arsenic removal with chemical pretreatment was assumed to be needed prior to discharge to the CCMUA POTW. All of the VOCs detected onsite were below the CCMUA limits.

Chemical precipitation transforms dissolved contaminants into an insoluble solid, removing the contaminant from the liquid phase and allowing for disposal. The process usually uses pH adjustment, addition of a chemical precipitant, and flocculation.

Several limitations exist including additional treatment, high costs, and complexity of inorganic mixtures. The process produces groundwater that may require pH adjustment and a sludge that potentially requires treatment or disposal at a hazardous waste facility. Complex mixtures of metals in the groundwater may reduce the effectiveness of the process or require additional treatment methods. Other metals removal processes may be evaluated during pre-design as part of this alternative.

As depicted in Figure 4-11 groundwater will be pumped to an oxidation tank and then transferred through an in-line chemical precipitation system (for metals removal). Additionally, radionuclides will be sampled for and treated, if necessary.

After treatment, the groundwater will discharge to the POTW. Controls will include on-off operation, high level alarms for all the tanks, and alarms for the operations of the precipitation system.

Discharge to POTW. The extracted groundwater will be discharged to the CCMUA POTW. The CCMUA POTW will require a permit to discharge groundwater. The permit will specify the pretreatment limits that must be met prior to discharge to the POTW collection system.

Groundwater Alternative 4— In Situ Geochemical Fixation and MNA. The objective of Groundwater Media Alternative 4 (G4) is to fixate the arsenic in situ to eliminate potentially costly and time consuming ex situ treatment methods. The in situ geochemical fixation involves blending in a polymer into the impacted groundwater area (the area of elevated arsenic concentrations) to a depth of approximately 17.5 feet. This depth includes the shallow Upper RPM aquifer and the underlying clay layer. The general locations where mixing will occur are presented in Figure 4-9.

The main remedial components of G4 are:

- Groundwater Use Restrictions
- Monitored Natural Attenuation
- In Situ Geochemical Fixation

The groundwater use restrictions and monitored natural attenuation are as described for Alternative G2.

In Situ Geochemical Fixation. In-situ Geochemical Fixation (IGF) involves transforming metal contaminants to naturally occurring low solubility precipitates. The conversion of contaminants to low solubility precipitates eliminates their mobility and prevents them from being drawn into water wells if any wells were installed at the site in the future. Compounds such as calcium polysulfide solutions decompose in water, reacting with carbon dioxide and oxygen to produce calcium thiosulfate and hydrogen sulfide. Metals are precipitated out of water as metal sulfides by the reaction with the calcium thiosulfate and H_2S.

The specific fixation compound and blending doses will be investigated in a pre-design bench scale study. A pilot study to evaluate the actual distribution of chemicals and the resulting effectiveness may also be performed prior to full scale injection. It is anticipated that in situ blending will be accomplished via a rotary type blender and associated chemical delivery equipment. It is estimated that the soil mixing required for this alternative would occur over the course of six months.

Cost Estimate Assumptions

- In situ geochemical fixation depth will be approximately 17.5′.
- Blender attachment to a hydraulic excavator works at the rated minimum of 500 CY/Day.
- 3mL/L Dose Rate for Calcium Polysulfide (CaPs).
- Ca(OH)2 added in 1:2 ratio to CaPS for pH control.

Groundwater Alternative 5 — Groundwater Collection and Treatment. The objective of Groundwater Media Alternative 5 (G5) is to aggressively remediate the contaminated groundwater plume by active removal of the contaminated groundwater for ex situ treatment and ultimate discharge.

The main remedial components of G5 are:

- Groundwater Use Restrictions
- Monitoring of Groundwater
- Groundwater Collection Wells
- Chemical Precipitation
- Discharge to POTW

The groundwater use restrictions and monitoring of groundwater are as described for Alternative G2. The discussion of the active collection system necessary for treatment of the impacted groundwater is presented below.

Groundwater Collection Wells. The objective of this component is to actively collect the entire plume. The groundwater extraction treatment system will consist of extraction wells, extraction pumps, connecting piping, chemical precipitation, and discharge to the POTW. Although details of the pumping rates will be determined during pre-design activities and during site pump tests, it has been initially calculated that 8 extraction wells within the plume will pump at a combined 85 gpm. The general locations of the extraction wells necessary to capture the plume are illustrated on Figure 4-10. The extraction pumps will be submersible pumps within extraction wells that will be installed within the extent of the plume.

Chemical Precipitation. Contaminant concentrations were estimated for the collection system discharge and compared against the CCMUA POTW pretreatment limits. Estimated concentrations were developed from the most recent RI sampling data or from the maximum concentrations measured in a specific monitoring well over time. Arsenic was the only groundwater contaminant that may exceed the limits. See Table 4-3 for expected contaminant values and POTW limits. Based on this evaluation, arsenic removal with chemical pretreatment was assumed to be needed prior to discharge to the CCMUA POTW. All of the VOCs detected onsite were below the CCMUA limits. The chemical precipitation treatment is as described for Alternative 3. It has been assumed that the system would be operated for 10 years to remove the majority of the contaminant mass (assumed to be seven and one-half pore volumes), and that MCLs in groundwater (with the likely exception of the shallow Upper PRM groundwater) will be met within the 10-year timeframe.

5.0 Detailed Analysis of Alternatives

5.1 Introduction

The detailed analysis of alternatives presents the relevant information needed to compare the remedial alternatives for soil and groundwater assembled for the Martin Aaron site. The detailed analysis of alternatives follows the development of alternatives, and precedes the selection of a final remedy. The extent to which alternatives are fully evaluated during the detailed analysis is influenced by the available data and the number and types of alternatives being analyzed.

Detailed analysis of alternatives consists of the following components:

- A detailed evaluation of each alternative against seven NCP evaluation criteria; and
- A comparative evaluation.

The detailed evaluation is presented in table format. The comparative evaluation is presented in text and highlights the most important factors that distinguish alternatives from each other.

5.2 Evaluation Criteria

In accordance with the NCP remedial actions must:

- Be protective of human health and the environment;
- Attain ARARs or provide grounds for invoking a waiver of ARARs that cannot be achieved;
- Be cost-effective;
- Utilize permanent solutions and alternative treatment technologies or resource-recovery technologies to the maximum extent practicable; and
- Satisfy the preference for treatment that reduces toxicity, mobility, or volume (TMV) as a principal element.

In addition, the NCP emphasizes long-term effectiveness and related considerations including:

- The long-term uncertainties associated with land disposal;
- The goals, objectives, and requirements of the Solid Waste Disposal Act;
- The persistence, toxicity, and mobility of hazardous substances and their constituents, and their propensity to bio-accumulate;
- The short-and long-term potential for adverse health effects from human exposure;
- Long-term maintenance costs;
- The potential for future remedial action costs if the selected remedial action fails; and
- The potential threat to human health and the environment associated with excavation, transportation, disposal, or containment.

Provisions of the NCP require that each alternative be evaluated against nine criteria listed in 40 CFR 300.430(e)(9). These criteria were published in the March 8, 1990 *Federal Register* (55 FR 8666) to provide grounds for comparison of the relative performance of the alternatives and to identify their advantages and disadvantages. This approach is intended to provide sufficient information to adequately compare the alternatives and to select the most appropriate alternative for implementation at the site as a remedial action. The evaluation criteria are:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- Community Acceptance; and
- State Acceptance

The criteria are divided into three groups: threshold, balancing, and modifying criteria. Threshold criteria must be met by a particular alternative for it to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—either they are met by a particular alternative, or that alternative is not considered acceptable. The two threshold criteria are overall protection of human health and the environment, and compliance with ARARs. If ARARs cannot be met, a waiver may be obtained in situations where one of the six exceptions listed in the NCP occur (see 40 CFR 300.430 (f)(1)(ii)(C)(1 to 6).

Unlike the threshold criteria, the five balancing criteria weigh the trade-offs between alternatives. A low rating on one balancing criterion can be compensated by a high rating on another. The five balancing criteria include:

- Long-term effectiveness and permanence;
- Reduction of TMV through treatment;
- Short-term effectiveness;
- Restoration Time Frame;
- Implementability; and
- Cost

The modifying criteria are community and state acceptance. These are evaluated following public comment and are used to modify the selection of the recommended alternative. The remaining seven evaluation criteria, encompassing both Threshold Balancing Criteria, are briefly described below.

5.2.1 Threshold Criteria

To be eligible for selection, an alternative must meet the two threshold criteria described below, or in the case of ARARs, must justify for a waiver that is appropriate.

Overall Protection of Human Health and the Environment

Protectiveness is the primary requirement that remedial actions must meet under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). A remedy is protective if it adequately eliminates, reduces, or controls all current and potential risks posed by the site through each exposure pathway. The assessment against this criterion describes how the alternative achieves and maintains protection of human health and the environment.

Compliance with ARARs

Compliance with ARARs is one of the statutory requirements of remedy selection. ARARs are cleanup standards, standards of control, and other substantive environmental statutes or regulations which are either "applicable" or "relevant and appropriate" to the CERCLA cleanup action (42 USC 9621 [d] [2]). Applicable requirements address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site. Relevant and appropriate requirements are those that while not applicable, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to environmental or technical factors at a particular site. The assessment against this criterion describes how the alternative complies with ARARs or presents the rationale for waiving an ARAR. ARARs can be grouped into three categories:

- **Chemical-specific:** ARARs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, establish the amount or concentration of a chemical that may remain in or be discharged to the environment.
- **Location-specific:** ARARs restrict the concentration of hazardous substances or the conduct of activities solely because they are in specific locations, such as flood plains, wetlands, historic places, and sensitive ecosystems or habitats.
- **Action-specific:** ARARs include technology- or activity-based requirements that set controls, limits, or restrictions on design performance of remedial actions or management of hazardous constituents.

5.2.2 Balancing Criteria

The five criteria listed below are used to weigh the trade-offs between alternatives.

Long-term Effectiveness and Permanence

This criterion reflects CERCLA's emphasis on implementing remedies that will ensure protection of human health and the environment in the long term as well as in the short term. The assessment of alternatives against this criterion evaluates the residual risks at a site after completing a remedial action or enacting a no action alternative and includes evaluation of the adequacy and reliability of controls.

Reduction of TMV through Treatment

This criterion addresses the statutory preference for remedies that employ treatment as a principal element. The assessment against this criterion evaluates the anticipated performance of the specific treatment technologies an alternative may employ. The criterion is specific to evaluating only how treatment reduces TMV and does not address containment actions such as capping.

Short-term Effectiveness

This criterion addresses short-term impacts of the alternatives. The assessment against this criterion examines the effectiveness of alternatives in protecting human health and the environment (i.e., minimizing any risks associated with an alternative) during the construction and implementation of a remedy until the response objectives have been met.

Implementability

The assessment against this criterion evaluates the technical and administrative feasibility of the alternative and the availability of the goods and services needed to implement it.

Cost

Cost encompasses all engineering, construction, and O&M costs incurred over the life of the project. The assessment against this criterion is based on the estimated present worth of these costs for each alternative. Present worth is a method of evaluating expenditures such as construction and O&M that occur over different lengths of time. This allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented. The present worth of a project represents the amount of money, which if invested in the initial year of the remedy and disbursed as needed, would be sufficient to cover all costs associated with the remedial action. As stated in the RI/FS guidance (EPA, 1988a), these estimated costs are expected to provide an accuracy of plus 50 percent to minus 30 percent. Appendix C provides a breakdown of the cost estimate for each of the alternatives.

The level of detail required to analyze each alternative against these evaluation criteria depends on the nature and complexity of the site, the types of technologies and alternatives being considered, and other project-specific considerations. The analysis is conducted in sufficient detail to understand the significant aspects of each alternative and to identify the uncertainties associated with the evaluation.

The cost estimates presented below have been developed strictly for comparing the alternatives. The final costs of the project and the resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, the implementation schedule, the firm selected for final engineering design, and other variables. Therefore, final project costs will vary from the cost estimates. Because of these factors, project feasibility and funding needs must be reviewed carefully before specific financial decisions are made or project budgets are established to help ensure proper project evaluation and adequate funding.

The cost estimates are order-of-magnitude estimates having an intended accuracy range of +50 to -30 percent. The range applies only to the alternatives as they are defined in Section 4 and does not account for changes in the scope of the alternatives. Selection of specific technologies or processes to configure remedial alternatives is intended not to limit flexibility during remedial design, but to provide a basis for preparing cost estimates. The specific details of remedial actions and cost estimates would be refined during final design.

5.3 Detailed Analysis of Soil Media Alternatives

The analysis consists of detailed and comparative evaluations of the remedial alternatives.

5.3.1 Detailed Evaluation

The following alternatives were developed and described in Section 4 for the soil target areas:

- Alternative S1 - No Further Action
- Alternative S2 – Cap and Institutional Controls
- Alternative S3 – Cap, Soil Vapor Extraction and In Situ Stabilization
- Alternative S4 – Cap, Excavation, Treatment, and Offsite Disposal
- Alternative S5 – Cap, Soil Vapor Extraction, Excavation, Treatment and Offsite Disposal
- Alternative S6 – Total Excavation, Treatment, and Offsite Disposal

These alternatives were evaluated in detail using the seven evaluation criteria described in Section 5.1. The detailed evaluations for these soil media alternatives are presented in Table 5-1.

5.3.2 Comparative Analysis

Overall Protection of Human Health and the Environment

The remedial action objectives pertinent to the soil target areas are:

- Prevention of human exposure, through contact, ingestion, or inhalation to contaminated soil that presents an unacceptable risk (i.e., HI greater than 1 or ELCR greater than $1x10^{-4}$ to $1x10^{-6}$);
- Prevention of erosion and offsite transport of soils contaminated at concentrations posing unacceptable risk (i.e., HI greater than 1 or ELCR greater than $1x10^{-4}$ to $1x10^{-6}$); and
- Remediation of contaminated soils, as necessary, to prevent further leaching of contaminants to groundwater that result in groundwater in excess of MCLs, NJDEP IGWSCC, NJDEP NRDCSCC, or, for the contaminants without SDWA MCLs, HI greater than 1 or ELCR greater than $1x10^{-4}$ to $1x10^{-6}$.

The no further action alternative is not protective because it allows continued leaching of VOCs and metals to groundwater without any means to evaluate the time until PRGs are met. Alternatives S2 through S6 are all considered protective of human health. Alternatives S3, S4, S5, and S6 include active treatment and/or removal of contaminated soils and historic fill exceeding PRGs. Through the use of active treatment and removal, these alternatives are more protective of human health and the environment since the impacted soils are eliminated from future exposure at the Site.

Alternative S2 relies primarily on an asphalt cap and institutional controls to meet all three remedial action objectives. It is permanent and protective; however, arsenic and VOCs will remain in place in these alternatives. Alternatives S3, S4 and S5 are more protective to human health and the environment than Alternatives S1 and S2 since active treatment (SVE for VOC impacted soils and stabilization of arsenic impacted soils) or soil removal and offsite disposal will meet the groundwater leaching RAOs faster than Alternatives S1 and S2. Alternative S3 uses in situ treatment for the VOCs and arsenic impacted soils and will be slightly less effective than Alternatives S4 because not all VOCs are typically removed with SVE. Alternatives S4 and S5 will also meet the RAOs for soil, through the removal of the contaminant mass continuing to leach to groundwater. These alternatives are more protective of human health and the environment than Alternatives S1 and S2 since they will eliminate leaching of arsenic and VOCs to groundwater in a shorter timeframe. Alternative S5 is similar in meeting the RAOs to Alternative S3, since they each use SVE. The excavation of arsenic impacted soil under Alternative S5 is expected to be slightly more effective than in situ stabilization.

Alternative S6 is the most protective of human health and the environment since it removes all impacted soils for offsite disposal, which would allow for unrestricted use of the site in the future.

Compliance with ARARs

All alternatives other than No Further Action, Alternative S1, are expected to comply with ARARs. Since all of the other alternatives include either exposure controls or complete removal, the main ARAR is to achieve the groundwater PRGs by eliminating leaching of arsenic and chlorinated VOCs to groundwater. Leaching of these compounds to groundwater at concentrations that could cause MCL exceedances would not be addressed under Alternative S1, but is addressed under the remaining alternatives. Location- and Action-specific ARARs would be met under all the alternatives.

Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of alternatives vary largely as a result of the adequacy and reliability of the systems implemented. Active treatment or removal, Alternatives S3, S4, S5, and S6, are more effective in the long-term, than passive alternatives like S2. Of these alternatives, S4, S5, and S6 (alternatives with some component of excavation and offsite disposal) are more permanent than in-situ alternatives, though much of the COC mass is transferred to a landfill rather than being destroyed. Alternative S6 offers the highest degree of long-term effectiveness because it is expected to achieve the greatest removal of arsenic and VOCs from the soils through excavation and offsite treatment and disposal. Alternative S4 is the next best alternative relative to long-term effectiveness since the largest mass is removed from the site. Alternatives S3 and S5 are ranked lower than S4 and S6, since they involve in situ treatment of the soil sources areas, but are still effective and permanent in the long-term. Alternative S2 followed by S1 are considered the next least effective alternatives because they do not remove TCE and/or arsenic or limit leaching to groundwater.

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives S1 and S2 do not significantly reduce the volume of contaminants through treatment. The only treatment in these alternatives is the natural attenuation of VOCs in soil. Alternatives S3 and S5 remove and destroy approximately 7,000 lbs. of VOCs via in-situ removal and offgas treatment. Alternative S3 also minimizes the leachability of approximately 100,000 lbs. of arsenic through in-situ treatment. Alternatives S4, S5, and S6 include solidification of about 8,000 CY of soil containing an estimated 75,000 lbs. of arsenic prior to offsite disposal in a landfill.

The largest TMV reduction is achieved through Alternative S3, with in situ treatment via SVE of 7,000 lbs. of VOCs and stabilization of approximately 100,000 lbs. of arsenic. Alternative S5 achieves the reduction of the 7,000 lbs. of VOCs along with minimizing the leachability of approximately 75,000 lbs. of arsenic prior to landfilling. Alternatives S4 and S6 rank after Alternative S5, with treatment of 75,000 lbs. of arsenic ex situ.

Short-term Effectiveness

All alternatives have minimal impacts with respect to the protection of workers, the community or the environment during remedial construction, assuming adequate monitoring is conducted and mitigative actions are taken. Alternatives S1, S2 and S3 have the least potential for construction-related impacts on workers, the community or the environment because they have minimal construction. Of these three alternatives, Alternative S3 has the highest risk to workers, due to the construction equipment necessary during stabilization. Alternatives S4, S5, and S6 have the potential for adverse impacts during construction to both workers and the community, related to VOC emissions, fugitive dust emissions, and truck traffic hauling impacted soils. Alternatives S4 and S6 have the greatest potential for impacts related to VOC emissions because the VOC impacted soils are excavated under both these alternatives as opposed to the in situ SVE of Alternatives S3 and S5.

Alternatives S4, S5, and S6 achieve RAOs more quickly than Alternatives S1, S2 and S3, since they each involve some type of excavation, which takes less time to remediate than in situ remedies. Alternatives S4 and S6 achieve remedial action objectives most quickly.

Air monitoring would be important for all of the excavation alternatives (S4, S5, and S6) as workers would need to be in the appropriate health and safety protection level during intrusive activities. Also emission control techniques such as the use of dust suppressants and minimizing the open working area of the excavation would be employed as needed to minimize adverse effects on workers and the community from VOC emissions.

Implementability

The main technical challenge for the soil remedial alternatives is in determining the proper in situ stabilization agent (Alternative S3) for the contaminants and concentrations seen in soils. Alternative S6 might be difficult to implement due to multiple property owners and the large volume of soil to be excavated. All of the other alternatives can be implemented with readily available materials and methods.

Cost

An overview of the cost analysis performed for this FS and the detailed breakdowns for each of the alternatives are presented in Appendix C, with the costs listed in Table 5-1.

The no further action alternative has the least present worth cost, as the only task associated with this alternative is the five-year review.

The lowest cost alternative, excluding the no action alternative, is S2 since this alternative only calls for the installation of a cap (lower capital costs than the other alternatives) and monitoring. Alternative S3 would incur the next highest costs due to the capital costs associated with SVE system infrastructure and stabilization materials. Alternative S5 would be the next most costly because it involves SVE treatment, excavation, and offsite disposal. Alternative S4 ranks next highest because of the larger excavation area that requires treatment (hazardous for arsenic) prior to disposal. The highest cost for treatment would result for Alternative S6, which requires total excavation, treatment, and offsite disposal.

5.4 Detailed Analysis of Groundwater Media Alternatives

5.4.1 Detailed Evaluation

The following alternatives for groundwater were developed and described in Section 4:

- Alternative G1 - No Further Action
- Alternative G2 – MNA and Institutional Controls
- Alternative G3 – Containment with Hydraulic Controls
- Alternative G4 – In Situ Geochemical Fixation and MNA
- Alternative G5 – Groundwater Collection and Treatment

These five alternatives were evaluated in detail using the seven evaluation criteria described in Section 5.1. The detailed evaluations for these groundwater media alternatives are presented in Table 5-2.

5.4.2 Comparative Analysis

Overall Protection of Human Health and the Environment

The groundwater remedial action objectives are:

- Remediate contamination in groundwater outside the soil source area (where contamination is continuing to leach to groundwater) to concentrations below MCLs and the NJDEP GWQC, or in the absence of MCLs, HI=1 or ELCR of $1x10^{-4}$ to $1x10^{-6}$ within a reasonable time frame, and
- Remediate groundwater within the soil source area (where contamination is continuing to leach to groundwater) to the extent practicable and minimize further migration of contaminants in groundwater.

The no further action alternative is not considered protective because it does not include groundwater monitoring or institutional controls to prevent access to contaminated groundwater. Future exposure to groundwater would result in unacceptable risks.

The remaining alternatives are considered protective. Alternative G2, the natural attenuation and institutional control alternative, is considered protective because it includes restrictive covenants on the property deeds to prevent groundwater use and it includes groundwater monitoring to verify natural attenuation. Alternative G2 eliminates human contact and slowly returns groundwater to MCLs, however, it is less protective since the migration of VOCs and arsenic could still occur in groundwater. Alternative G3 involves the hydraulic control of the downgradient portion of the groundwater plume as well as some groundwater collection in the source area. It achieves the second RAO in a short time frame by preventing continued migration and allows for the first RAO to be achieved eventually through a combination of natural flushing and collection of groundwater in the source area. Alternative G4 is protective of human health and the environment since arsenic in groundwater is fixated in situ and does not migrate after treatment. It provides treatment to approximately 80 percent of the arsenic that is dissolved in the groundwater. Alternative G5 is the most protective of human health and the environment and meets the RAOs in the fastest time by aggressively removing the contaminant mass both within the plume and along the downgradient portions of the plume. Neither Alternative G3 nor G5 however may lead to meeting the arsenic MCL in the shallow Upper PRM groundwater because of the relatively thin saturated thickness and low permeability of the soil. These conditions will likely lead to dewatering of the shallow groundwater above the clay and limit the ability to flush dissolved arsenic to the collection wells.

Compliance with ARARs

Appendix A presents a compilation of all the State and Federal chemical-specific, location-specific, and action-specific ARARs considered for the Martin Aaron Site. With the exception of the no further action alternative, all would meet ARARs. The groundwater treatment Alternatives (G3 and G5) and the in situ geochemical fixation Alternative (G4) would meet the ARARs in less time than the no further action or natural attenuation/institutional control alternatives. Alternative G4 meets ARARs sooner for the arsenic portion of the plume than alternatives G2, G3, and G5.

Air treatment for the emissions under the groundwater pumping alternatives (G3 and G5) would be implemented if required to meet Clean Air Act and applicable NJDEP-specific ARARs.

Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of the in situ treatment alternative (G3) and the groundwater collection and treatment alternatives (G4 and G5) are better than the other two alternatives because these involve active reduction in TCE, cis 1,2-DCE, VC and arsenic concentrations in groundwater.

Alternative G5 ranks slightly higher than Alternative G3 (the two pumping alternatives) in long-term effectiveness and permanence since Alternative G5 removes a larger mass of TCE and arsenic. Alternative G4 ranks higher than alternatives G3 and G5 for the arsenic plume because the arsenic is immediately fixated after injection. However, this alternative ranks lower than the pumping alternatives (G3 and G5) for the VOC portion of the plume.

The remaining alternatives, the no further action (G1) and natural attenuation/institutional controls (G2) alternatives, are similar in their long-term effectiveness and permanence, which is less than alternatives G3, G4, and G5, since natural processes are the only technology relied on to reduce the concentrations of TCE, cis-1,2-DCE, VC, and arsenic.

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative G5 is the best alternative for reduction of TMV since it removes and destroys the most TCE, cis 1,2-DCE, and VC. It also would remove a large portion (assumed to be over 99 percent) of arsenic in groundwater through active pore flushing. It is estimated that there are approximately 9 lbs. of VOCs and 40 lbs. of arsenic in the upper PRM aquifer. Alternative G4 follows Alternative G5 for reduction of TMV, which reduces the mobility of approximately 32 lbs. of arsenic. Alternative G3 is estimated to removal about 2 lbs. of VOCs within the first year and nearly all the VOCs in subsequent years of operation.

The majority of the VOCs and arsenic in the collected groundwater of Alternatives G3 and G5 are removed during treatment processes at the POTW. Alternatives G1 and G2 do not reduce the toxicity, mobility or volume of contamination due to the lack of active treatment, and do not meet the statutory preference for treatment.

Short-term Effectiveness

The no further action alternative and Alternative G2 do not have impacts because they involve no remedial construction. Alternatives G3 and G5 have minimal impacts with respect to the protection of workers during remedial construction, protection of community during remedial action, and environmental impacts of remedial action. Alternative G4 has potential worker, community and environmental impacts due to the injection of a high pH material into the aquifer and the substantial soil mixing. This process involves mechanical mixing of about 64,000 CY of soil over the course of 6 months. Some emissions of VOCs and dust would be unavoidable, though risks to public health would be minimized through air monitoring and emission control measures. The G4 alternative is also the most likely to result in impacts to the environment as a result of the soil mixing and erosion potential.

The short-term effectiveness with respect to the time until the RAOs are achieved is shortest for the groundwater collection and treatment alternatives (G3 and G5) since these alternatives are actively reducing the concentrations of both VOCs and arsenic in groundwater. For Alternative G5, it is expected that MCLs in groundwater (with the likely exception of the shallow Upper PRM groundwater) will be achieved in approximately 10 years. Alternative G3 is estimated to require about 20 years until RAOs are met. Alternative G4 will achieve the RAOs faster than Alternative G3 for arsenic, but will rely on natural attenuation of the VOC plume, which will take longer under Alternative G4, an estimated 40 years . It is assumed that more than 50 years will be required to achieve MCLs for alternatives G1 and about 45 years for alternative G2 (assumes soil source is capped, removed or treated).

Implementability

All alternatives can be implemented at the site, and no technical or administrative implementability problems are expected for any of the alternatives. However, Alternative G4 will require extensive permitting for injection of the geochemical fixation mixture into the aquifer. Proper chemical dose and mix for precipitation of arsenic is required to achieve the goals of this alternative.

Cost

A summary of the estimated costs for each of the groundwater media alternatives is presented on Table 5-2 and in more detail in Appendix C. The table breaks down the estimated capital, operations and maintenance, and present net worth cost.

The no further action alternative has the least present worth cost, as the only task associated with this alternative is the 5 year review (assumed for 50 years).

The highest present worth cost would result from Alternative G3 at $7,800,000. The treatment requires long-term operations that would average costs of approximately $580,000 a year. The next highest cost would be incurred from alternative G5, at $6.6 million to implement followed by Alternative G4 at $1.7 million. Alternative G2 has the lowest cost ($550,000) of any of the alternatives with the exception of No Further Action.

6.0 References

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Tables

TABLE 2-1

Universal Treatment Standards (UTS) for Contaminated Soil

Feasibility Study

Martin Aaron Site

Contaminant of Concern	UTS (mg/kg)	10 x UTS (mg/kg)	Maximum Soil Concentration (mg/kg)	Potential for Soil to Require Treatment to Meet LDRs for Contaminated Soil (Yes or No)
Dieldrin	0.13	1.3	1.3	No
Tetrachloroethene	6	60	110	No
Benzene	10	100	31	No
Trichloroethene	6	60	630	Yes
TCLP Constituents	**TCLP (mg/kg)**	**10 x UTS (mg/kg)**	**Maximum Soil Concentration (mg/kg)**	**Potential for Soil to Require Treatment to Meet LDRs for Contaminated Soil (Yes or No)**
Tetrachloroethene	0.7	7	110	No
Benzene	0.5	5	31	No
Trichloroethene	0.5	5	630	No
Arsenic	5	50	23,300	Yes

TABLE 2-2
Summary of PRG Exposure Pathways
Feasibility Study
Martin Aaron Site

Media	Exposure Route	Resident	Industrial Worker
Surface Soil[1] and Subsurface Soil[2] Martin Aaron property	Ingestion		X
	Dermal		X
	Inhalation		X
Surface Soil[1] and Subsurface Soil[2] Junkyard	Ingestion		X
	Dermal		X
	Inhalation		X
Surface Soil[1] and Subsurface Soil[2] Row Homes/Industrial Area	Ingestion	X	
	Dermal	X	
	Inhalation	X	
Surface Soil[1] and Subsurface Soil[2] South Jersey Port property	Ingestion		X
	Dermal		X
	Inhalation		X
Subsurface Soil Within 2 feet of Water Table[3] All Areas	Leaching to GW	X	
Groundwater Upper and Middle PRM Aquifer	Ingestion	X	
	Dermal	X	
	Inhalation	X	

Notes:

1. Includes top 2 feet of soil.
2. Includes 2 – 10 feet below ground surface (and samples below concrete).
3. Includes subsurface soil within 2 feet of the groundwater table. Where soils data is unavailable within 2 feet of water table, the nearest subsurface soil sample to the water table is used as a proxy sample.

TABLE 2-3
Soil PRGs
Feasibility Study
Martin Aaron Site

Parameter	EPA Region 9 PRG (mg/kg) 1 x 10^{-4} or HI =1 Residential	Source	1 x 10^{-6} or HI =1 Residential	Source	1 x 10^{-4} or HI =1 Industrial	Source	1 x 10^{-6} or HI =1 Industrial	Source	Residential		Non Residential		Protection of GW	
Acetophenone	0.49	nc	0.49	nc	1.60	nc	1.60	nc						
Aldrin	1.8	nc	0.029	ca*	10	ca	0.10	ca	0.04		0.17		50	
Aluminum	76000	nc	76000	nc	100000	max	100000	max						
Antimony	31	nc	31	nc	410	nc	410	nc	14		340			(h)
Arsenic	22	nc	0.39	ca*	160	ca	1.60	ca	20	(e)	20	(e)		(h)
Barium	5400	nc	5400	nc	67000	nc	67000	nc	700		47000	(n)		(h)
Benzene	7.1	nc	0.60	ca*	24	nc	1.30	ca*	3		13		1	
Benzo(a)anthracene	62	ca	0.62	ca	210	ca	2.10	ca	0.9		4		500	
Benzo(a)pyrene	6.2	ca	0.062	ca	21	ca	0.21	ca	0.66	(f)	0.66	(f)	100	
Benzo(b)fluoranthene	62	ca	0.62	ca	210	ca	2.10	ca	0.9		4		50	
Benzo(k)fluoranthene	620	ca	6.20	ca	2100	ca	21	ca	0.9		4		500	
Bromomethane	3.90	nc	3.90	nc	13	nc	13	nc	79		1000	(d)	1	
Cadmium	37	nc	37	nc	450	nc	450	nc	39		100			(h)
Carbazole	2400	ca	24	ca	8600	ca	86	ca						
Chlordane - alpha	35	nc	0.11	ca	400	nc	0.38	ca						
Chloroform	3.60	ca/nc	3.60	ca/nc	12	ca/nc	12	ca/nc	19	(k)	28	(k)	1	
Chromium	21000	ca	210	ca	45000	ca	450	ca	240	(g)	20	(l)		(h)
Chrysene	6200	ca	62	ca	21000	ca	210	ca	9		40		500	
Copper	3100	nc	3100	nc	41000	nc	41000	nc	600	(m)	600	(m)		(h)
DDE-4,4'	170	ca	1.70	ca	700	ca	7	ca	2		9		50	
DDT-4,4'	170	ca*	1.70	ca*	700	ca*	7	ca*	2		9		500	
Dibenzo(a,h)anthracene	6.2	ca	0.062	ca	21	ca	0.21	ca	0.66	(f)	0.66	(f)	100	
Dibenzofuran	290	nc	290	nc	3100	nc	3100	nc						
Dichloroethylene-1,2 cis	43	nc	43	nc	150	nc	150	nc	79		1000	(d)	1	

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TABLE 2-3
Soil PRGs
Feasibility Study
Martin Aaron Site

Parameter	EPA Region 9 PRG (mg/kg) 1 x 10^-4 or HI =1 Residential	Source	1 x 10^-6 or HI =1 Residential	Source	1 x 10^-4 or HI =1 Industrial	Source	1 x 10^-6 or HI =1 Industrial	Source	Residential		Non Residential		Protection of GW	
Dieldrin	3.0	ca	0.030	ca	11	ca	0.11	ca	0.042		0.18		50	
Ethylbenzene	890	ca	8.90	ca	2000	ca	20	ca	1000	(d)	1000	(d)	100	
Fluoranthene	2300	nc	2300	nc	22000	nc	22000	nc	2300		10000	(c)	100	
Heptachlor	11	ca	0.11	ca	38	ca	0.38	ca	0.15		0.65		50	
Heptachlor Epoxide	0.79	nc	0.05	ca*	8.0	nc	0.19	ca*						
Indeno(1,2,3-cd)pyrene	62	ca	0.62	ca	210	ca	2.10	ca	0.9		4		500	
Iron	23000	nc	23000	nc	100000	max	100000	max						
Lead	400	nc	400	nc	750	nc	750	nc	400	(p)	600	(q)		(h)
Manganese	1800	nc	1800	nc	19000	nc	19000	nc						
Mercury	6.10	nc	6.10	nc	62	nc	62	nc	14		270			(h)
Naphthalene	56	nc	56	nc	190	nc	190	nc	230		4200		100	
Nickel	1600	nc	1600	nc	20000	nc	20000	nc	250		2400	(k,n)		(h)
Pcb-araclor 1254	1.1	nc	0.22	ca**	11	nc	0.74	ca*	0.49		2		50	
Pcb-araclor 1260	22	ca	0.22	ca	74	ca	0.74	ca	0.49		2	**	50	**
Phenanthrene	2300	nc	2300	nc	29000	nc	29000	nc						
Phthalate, bis(2-ethylhexyl) (DEHP)	1200	nc	35	ca*	12000	nc/ca	120	ca	49		210		100	
Pyrene	2300	nc	2300	nc	29000	nc	29000	nc	1700		10000	(c)	100	
Silver	390	nc	390	nc	5100	nc	5100	nc	110		4100	(n)		(h)
Tetrachloroethylene	150	ca*	1.50	ca*	340	ca*	3.40	ca*	4	(k)	6	(k)	1	
Thallium	5.20	nc	5.20	nc	67	nc	67	nc	2	(f)	2	(f)		(h)
Toluene	520	sat	520	sat	520	sat	520	sat	1000	(d)	1000	(d)	500	
Trichloroethylene	5.3	ca	0.053	ca	11	ca	0.11	ca	23		54	(k)	1	
Vanadium	550	nc	550	nc	7200	nc	7200	nc	370		7100	(n)		(h)
Vinyl chloride	7.9	ca	0.079	ca	75	ca	0.75	ca	2		7		10	

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TABLE 2-3
Soil PRGs
Feasibility Study
Martin Aaron Site

Parameter	EPA Region 9 PRG (mg/kg)													
	1×10^{-4} or HI =1 Residential	Source	1×10^{-6} or HI =1 Residential	Source	1×10^{-4} or HI =1 Industrial	Source	1×10^{-6} or HI =1 Industrial	Source	Residential		Non Residential		Protection of GW	
Xylenes, total	270	nc	270	nc	420	sat	420	sat	410		1000	(d)	67	(s)
Zinc	23000	nc	23000	nc	100000	max	100000	max	1500	(m)	1500	(m)		(h)

NOTES:
[shaded] = Exceeds Soil PRG
Units are presented in mg/kg
ca - Cancer PRG
ca* (where: nc < 100X ca) ca** (where: nc < 10X ca)
nc - Noncancer PRG
sat - Soil Saturation

max - Ceiling limit
PRG - Preliminary Remediation Goal

NJDEP Soil Cleanup Criteria Notes
(c) Health based criterion exceeds the 10,000 mg/kg maximum for total organic contaminant
(d) Health based criterion exceeds the 1000 mg/kg maximum for total volatile organic contaminants.
(e) Cleanup standard proposal was based on natural background.
(f) Health based criterion is lower than analytical limits; cleanup criterion based on practical quantitation level.
(g) Criterion based on the inhalation exposure pathway.
(h) The impact to ground water values for inorganic constituents will be developed based upon site specific chemical and physical parameters.
(i) Site specific determination required for SCC for the allergic contact dermatitis exposure pathway.
(k) Criteria based on inhalation exposure pathway, which yielded a more stringent criterion than the incidental ingestion exposure pathway.
(m) Criterion based on ecological (phytotoxicity) effects.
(n) Level of the human health based criterion is such that evaluation for potential environmental impacts on a site by site basis is recommended.
(p) Criterion based on the USEPA Integrated Exposure Uptake Biokinetic (IEUBK) model utilizing the default parameters.
The concentration is considered to protect 95% of target population (children) at a blood lead level of 10 ug/dl.
(q) Criteria were derived from a model developed by the Society for Environmental Geochemistry and Health (SEGH) and were designed to be protective for adults in the workplace.
(s) Criterion based on new drinking water standard.

** PCBs (Polychlorinated biphenyls) criteria are used.

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TABLE 2-4
Groundwater PRGs
Feasibility Study
Martin Aaron Site

Parameter Name	Federal MCL ug/l	R9 PRG Tap Water ug/l	Source	NJ DEP Groundwater Quality Criteria ug/l	Source
Aluminum		36000	nc	200	N.J.A.C. 7:9-6
Antimony	6	15	nc	20	N.J.A.C. 7:9-6
Arsenic	10	0.045	ca	8	N.J.A.C. 7:9-6
Barium	2000	2600	nc	2,000	N.J.A.C. 7:9-6
Benzene	5	0.34	ca*	1.0	N.J.A.C. 7:9-6
Beryllium	4	73	nc	20	N.J.A.C. 7:9-6
Cadmium	5	18	nc	4	N.J.A.C. 7:9-6
Chlordane - alpha	2	0.02	ca	0.50	(c) - N.J.A.C. 7:9-6
Chloroethane		4.6	ca	100	GWQS Interim
Chromium	100	110	nc	100	N.J.A.C. 7:9-6
Cobalt		730	nc	100	GWQS Interim
Copper	1300	1500	nc	1,000	N.J.A.C. 7:9-6
Cresol-o		1800	nc	350	Calculated
Cresol-p		180	nc	35	Calculated
Dichlorobenzene-1,3		5.5	nc	600	N.J.A.C. 7:9-6
Dichlorobenzene-1,4	75	0.50	ca	75	N.J.A.C. 7:9-6
Dichloroethane-1,1		810	nc	50	GWQS Interim
Dichloroethane-1,2	5	0.12	ca*	2.0	N.J.A.C. 7:9-6
Dichloroethene-1,2 trans	100	120	nc	100	N.J.A.C. 7:9-6
Dichloroethylene-1,2 cis	70	61	nc	70	GWQS Interim
Dichloropropane-1,2	5	0.16	ca*	1.0	N.J.A.C. 7:9-6
Dieldrin		0.0042	ca	0.030	N.J.A.C. 7:9-6
Ether, bis(2-chloroethyl)		0.0098	ca	10	N.J.A.C. 7:9-6
Ethylbenzene	700	2.9	ca	700	N.J.A.C. 7:9-6
Heptachlor Epoxide	0.2	0.0074	ca*	0.20	N.J.A.C. 7:9-6
Iron		11000	nc	300	N.J.A.C. 7:9-6
Manganese		880	nc	50	N.J.A.C. 7:9-6
Methyl isobutyl ketone (4-methyl-2-pentanone)		160	nc	400	N.J.A.C. 7:9-6
Methyl tertiary butyl ether (MTBE)		13	ca	70	GWQS Interim
Naphthalene		6.2	nc	300	GWQS Interim
Nickel		730	nc	100	N.J.A.C. 7:9-6
Nitrosodiphenylamine-n		14	ca	20	N.J.A.C. 7:9-6
Phenol		22000	nc	4,000	N.J.A.C. 7:9-6
Selenium	50	180	nc	50	N.J.A.C. 7:9-6
Tetrachloroethylene	5	0.66	ca	1	N.J.A.C. 7:9-6

TABLE 2-4
Groundwater PRGs
Feasibility Study
Martin Aaron Site

Parameter Name	Federal MCL ug/l	R9 PRG Tap Water ug/l	Source	NJ DEP Groundwater Quality Criteria ug/l	Source
Thallium	2	2.4	nc	10	N.J.A.C. 7:9-6
Trichloroethane-1,1,2	5	0.20	ca	3	N.J.A.C. 7:9-6
Trichloroethylene	5	0.028	ca	1	N.J.A.C. 7:9-6
Vanadium		260	nc	49	Calculated
Vinyl chloride	2	0.020	ca	5	N.J.A.C. 7:9-6
Xylenes, total	10000	210	nc	1,000	GWQS Interim
Zinc		11000	nc	5,000	N.J.A.C. 7:9-6

NOTE:

= COPC Exceeds PRG in Groundwater

= COPC Exceeds PRG and May also Exceed Background

Units are presented in ug/L

ca - Cancer PRG

ca* (where: nc < 100X ca)

nc - Noncancer PRG

MCL - Maximum Contaminant Level

GWQS - NJDEP Groundwater Quality Standards

N.J.A.C. 7:9-6 - NJDEP Ground Water Quality Standards

Calculated - calculated according to N.J.A.C. 7:9-6.7.

PRGs for metal results will be applied to dissolved results only because metals are at very high concentrations in soil and turbidity in groundwater samples can result in very high bias in sample results.

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TABLE 2-5
Areas and Volumes of Soil - *Contamination Exceeding PRGs*
Feasibility Study
Martin Aaron Site

PRG	Area (Square Feet)	Soil Volume (CY)
VOCs, SVOCs, PCBs, pesticides over 1x10-6 ELCR or HI=1, or NJDEP PRGs	286,658	89,021
VOCs exceeding 1x10-4 ELCR, HI=1, or NJDEP PRGs	28,642	10,608
Arsenic > 500 mg/kg	22,716	8,413
VOCs exceeding 1x10-4 ELCR, HI=1, or NJDEP PRGs and Arsenic > 500 mg/kg	51,358	19,021

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TABLE 3-1
Technology/Process Option Evaluation - Soils
Feasibility Study
Martin Aaron Superfund Site

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
No Further Action	None	None	No action.					Required for comparison by NCP; does not meet RAOs.
Institutional Controls	Access Restrictions	***Fencing***	***Restrict access to contaminated soils through fencing.***	***Technically implementable***	***Fair***	***Good***	***Low/Low***	***Does not meet RAOs; site is currently fenced. Current fence was repaired during the Remedial Investigation and is in good shape.***
		Land Use Restrictions	Restrict access to contaminated soils through restrictive covenants on property deeds (Deed Notice).	Technically implementable	Fair	Fair	Low/Low	Does not meet RAOs when implemented alone; may be applicable in conjunction with other technologies.
Containment	Surface Controls	Grading	Reshape topography to control infiltration, runoff, and erosion.	Technically implementable	Demonstrated	Good	Low/Low	Potentially feasible; typically used in conjunction with capping and other technologies.
		Revegetation	Add topsoil, seed and fertilize to establish vegetation (to control erosion and reduce infiltration).	Technically implementable	Demonstrated	Good	Low/Low	Potentially feasible, but does not match future land use plans as a stand along option. Can be used in conjunction with other options to meet future use needs.
	Capping	Soil	Place clay over contaminated soils. Includes a cover layer to protect clay.	Technically implementable	Demonstrated	Good	Moderate/ Moderate	Potentially feasible; future industrial land use make clay caps impractical.
		Pavement	Place asphalt or concrete over contam-inated soils.	Technically implementable	Demonstrated	Fair	Low/ High	Potentially feasible.
		GCL/ Synthetic Membrane	***Place GCL or synthetic material over contaminated soils; includes a protective cover layer.***	***Technically implementable***	***Demonstrated***	***Good***	***Moderate/ High***	***Potentially feasible; future industrial land use make synthetic caps impractical.***
		Combination of pavement and soil	Place combined soil and paved cover over contaminated soils.	Technically implementable	Demonstrated	Good	High/ High	Potentially feasible

TABLE 3-1
Technology/Process Option Evaluation - Soils
Feasibility Study
Martin Aaron Superfund Site

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
Containment (cont.)	*Horizontal Subsurface Barriers*	*Block Displacement*	*Encapsulate block of soil with grout in conjunction with vertical barriers.*	*Not applicable to sands at site; typically used in hard rock environments*	*Fair*	*Fair*	*High/Low*	*Usually more feasible for isolated and/or small soil contaminant areas.*
		Grout Injection	*Create barrier by pressure injection of grout.*	*Not applicable to the sands at site; typically used in hard rock environments*	Fair	*Fair*	*High/Low*	*Usually more feasible for isolated and/or small soil contaminant areas. Not as feasible in heterogeneous soils.*
In situ Treatment	Physical/ Chemical	*Oxidation*	*Degrade contaminants by chemical (ozone or hydrogen peroxide), photo, or other oxidation techniques.*	*Difficult and expensive to determine effectiveness; unproven technology*	*Effective for VOC compounds, but not for metals*	*Low*	*Moderate/ High*	*Not an effective technology for metals.*
		Washing/ Flushing	*Wash or flush soil with water or surfactant.*	*Technically implementable*	*Potential*	*Fair to Good*	*Moderate to High/ NA*	*Complex waste mixture of metals and volatile compounds makes formulating a washing fluid and strategy difficult and reduces the effectiveness. Very costly relative to mass removed.*
		Stabilization	Immobilize contaminants using solidification agents.	Technically implementable	Good	Fair	Moderate/ NA	Potentially feasible. Has been effectively used to immobilize inorganics.
		Vitrification	*Melt/solidify soil matrix using electric currents.*	*Technically implementable*	*Potential*	*Fair*	*High/NA*	*Limited commercial applications. Heating of soil may allow spreading to uncontaminated soil. Very costly technology relative to other technologies.*
		Vapor Extraction	Extract contaminants by establishing a vacuum.	Technically implementable	Potential	Fair	Moderate/ Moderate	Potentially feasible. Effective and commonly used to remove VOCs from soils. Not effective on metals; off gas may require additional treatment;
	Biological	Natural Attenuation	Natural biological degradation by aerobic and anaerobic organisms in unsaturated zone.	Technically implementable	Potential	Fair	Low/Low	Potentially feasible.

TABLE 3-1
Technology/Process Option Evaluation - Soils
Feasibility Study
Martin Aaron Superfund Site

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
In situ Treatment (cont.)	Biological (cont.)	*Bioventing*	*Biologically degrade organics through stimulation of aerobic organisms by the addition of oxygen in air.*	*Technically implementable*	*Poor for chlorinated VOCs present at site.*	*Fair*	*Low/Low*	*Not effective for chlorinated VOCs.*
	Thermal	*Hot Air or Steam Stripping*	*Inject hot air or steam/ recover vapors (a variation of vapor extraction).*	*Technically implementable*	*Potential*	*Fair to Good*	*High/NA*	*Much more costly than other in situ technologies such as vapor extraction and bioventing. Typically used for NAPL removal.*
		Radio Frequency Stripping	*Use network of Radio Frequency Transmit-ters to heat soil; collect vaporized contaminants with vapor extraction system.*	*Technically implementable*	*Potential*	*Fair to Good*	*High/NA*	*Much more costly than other in situ technologies such as vapor extraction and bioventing.*
Excavation and Ex Situ Treatment	Removal	Backhoe/Front -end Loader	Physically remove shallow soils.	Technically implementable	Demonstrated	Good	Low/NA	Potentially feasible.
	Physical/ Chemical	*Oxidation*	*Degrade contaminants by chemical, photo, or other oxidation.*	*Technically implementable*	*Potential*	*Good*	*Moderate to High/ NA*	*Costly for treating VOC impacted soils. Soil may require offsite disposal in a Subtitle C landfill following oxidation treatment. Treated soil containing elevated inorganics would require solidification prior to disposal. Treatability testing required. The technical complexity, multiple unit processes and potentially high cost make this poorly suited to soil remediation.*
		Stabilization	Immobilize contam-inants.	Technically implementable	Potential	Fair	Moderate/ NA	Potentially feasible for inorganic contaminated soils; not applicable to volatile/semi-volatile contaminated soils

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TABLE 3-1
Technology/Process Option Evaluation - Soils
Feasibility Study
Martin Aaron Superfund Site

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
Excavation and Ex Situ Treatment (cont.)	Physical/ Chemical (cont.)	*Vitrification*	*Melt/solidify soil matrix.*	*Technically implementable*	*Potential*	*Poor*	*Very High/ NA*	*Control of volatile emissions is necessary. Very high cost of treatment. Vitrified soil mass may require disposal in RCRA hazardous waste landfill adding to already high treatment cost. Technical implementability is poor because it is complex to operate, requiring specialized training and skills.*
		Vapor Extraction	*Purge volatiles by forcing clean air through soil piles.*	*Technically implementable*	*Potential*	*Good*	*Moderate/ NA*	*Not effective on inorganics; large treated footprint needed for system does not match future land use plans.*
		Solvent Extraction	*Fractionates soil into three phases (soil, water, solvent).*	*Limited effectiveness on SVOCs, very complex, requires multiple processes*	*Potential*	Fair	*High/ High*	*Complex and costly technology that is ineffective on SVOCs.*
	Biological	*Aerobic Biological Treatment*	*Excavated soils are treated in piles or windrows and aerated either by tilling or through a network of air lines.*	*Technically implementable*	*Demonstrated for BTEX degradation but is not effective for CVOCs or metals*	*Fair*	*Moderate/ NA*	*Not effective for CVOCs which are the main COPCs.*
	Thermal	*Low-Temp Desorption*	*Desorb contaminants/ treat offgas.*	*Technically implementable*	*Potential*	*Fair*	*High/NA*	*Not cost competitive; treatment of off gas costly. Not applicable for metals contaminated soils.*
		Onsite Incineration	*Combust soils at high temperature.*	*Technically implementable*	*Demonstrated*	*Fair*	*High/ NA*	*Not cost competitive. Extensive treatability testing required; air treatment and permitting requirements are substantial.*
		Plasma	*Expose soils to super-heated plasma.*	*Technically implementable*	*Potential*	*Poor*	*High/ NA*	*Extensive treatability testing required; costs similar to incineration; unproven technology.*
		Infrared	*Decompose contaminants with infrared radiation.*	*Unproven technology*	Potential	*Poor*	*High/NA*	*Extensive treatability testing required; costs similar to incineration; unproven technology.*

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TABLE 3-1
Technology/Process Option Evaluation - Soils
Feasibility Study
Martin Aaron Superfund Site

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
Excavation and Ex Situ Treatment (cont.)	***Thermal (cont.)***	***Wet Air Oxidation***	***Use high temperature and pressure to thermally oxidize contaminants.***	***Technically implementable***	***Potential***	***Fair***	***High/ NA***	***Lengthy, extensive treatability testing required; energy consumptive, expensive.***
		Offsite Incineration	***Combust soils in offsite commercial incinerator.***	***Technically implementable***	***Demonstrated***	***Good***	***High/ NA***	***Not cost competitive when comparing to other offsite treatment/disposal options.***
Disposal	***Onsite***	***Backfill***	***Use treated soils to backfill excavations.***	***Technically implementable***	***Demonstrated***	***Fair***	***Low/ NA***	***Re-disposal of treated soil onsite will limit future site use. Will require approval by regulators.***
	Offsite	RCRA Subtitle C or D Landfill	Remove material for disposal in RCRA Subtitle C or D permitted landfill.	Technically implementable	Demonstrated	Fair	Moderate/ NA	Soils are subject to land disposal restrictions; disposal in Subtitle C landfill may be needed if soil remains a characteristic hazardous waste following treatment; otherwise disposal in Subtitle D Landfill.

Effectiveness is the ability to perform as part of a comprehensive alternative that can meet RAOs under conditions and limitations that exist at the site.

Implementability is the likelihood that the process could be implemented as part of the remedial action plan under the regulatory, technical, and schedule constraints.

Cost is for comparative purposes only, relative to other processes/technologies that perform similar functions.

Process options that have been screened out are italicized and bolded.

GW Groundwater
NCP National Contingency Plan
NPL National Priority List
NA Not applicable
RAOs Remedial Action Objectives
RCRA Resource Conservation and Recovery Act
SVOCs Semi-volatile organic contaminants
SVE Soil vapor extraction
TCLP Toxicity Characteristic Leaching Procedure
VOCs Volatile Organic Contaminants

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TABLE 3-2
Technology/Process Option Evaluation – Groundwater
Feasibility Study
Martin Aaron Site

General Response Action	Remedial Technology	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
No Further Action	None	None	No action	Technically implementable	None	Good	None/ Low	May expose future GW users; does not meet RAOs; required for comparison by NCP.
Institutional Controls	Access Restrictions	Eliminate Future Use of groundwater	Property in the area impacted by contaminated groundwater would require restrictions on GW use.	Technically implementable	Demonstrated	Good	Moderate/Low	Potentially applicable in conjunction with other technologies.
		Monitoring	Continue sampling and analysis of groundwater.	Technically implementable	None	Good	Low/Low	Potentially applicable in conjunction with other technologies.
Alternate Water Supply	Access Restrictions	***New Bedrock Water Supply Wells***	***Installation of new residential wells in the sandstone bedrock.***	***Technically implementable***	***Demonstrated***	***Poor***	***Low/Low***	***Residents are connected to municipal water supply system.***
Monitored Natural Attenuation	Access Restrictions	New Bedrock Water Supply Wells	Use of naturally occurring physical, chemical and biological processes such as dispersion, biodegradation and retardation to reduce concentrations of contaminants.	Technically implementable	Demonstrated	Good	Low/Low	Potentially feasible.
Containment	***Vertical Subsurface Barriers***	***Grout Curtain***	***Create subsurface barrier to horizontal GW flow by grout injection.***	***Technically implementable***	***Fair***	***Fair***	***High/NA***	***Not sufficiently effective or cost competitive for depths of 100 or more feet that would be required.***
		Slurry Walls	***Create subsurface barrier to horizontal GW flow by installing clay slurry wall.***	***Not technically implementable at depths of over 50 feet that would be required; may not be nearby source of clay***	***Poor***	***Fair***	***Moderate/ Low***	***Not sufficiently effective or cost competitive for depths of 100 or more feet that would be required.***
		Sealable Joint Sheet Piling	***Create subsurface barrier to horizontal GW flow by installing interlocking piles***	***Technically implementable, but limited by depth***	***Good***	***Good***	***High/NA***	***Depth would limit implementability.***

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TABLE 3-2
Technology/Process Option Evaluation – Groundwater
Feasibility Study
Martin Aaron Site

General Response Action	Remedial Technology	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
Containment (cont.)	***Vertical Subsurface Barriers (cont.)***	***Grout Injection***	***Create barrier by pressure injection of grout***	***Not applicable to heterogeneous stratigraphy at the site; typically used in hard rock environments***	***Good***	***Good***	***High/NA***	***Depth would limit implementability.***
	Hydraulic Controls	Wells (horizontal and/or vertical)	Extract GW to create hydraulic barrier to offsite migration of contaminants	Technically implementable	Demonstrated	Good	Moderate/ Low	Feasible.
In Situ Treatment	Physical-Chemical	***Oxidation***	***Inject/extract oxidants to degrade contaminants***	***Treatability testing required; transmissivity and aquifer heterogeneity would limit effectiveness***	***Potential***	***Fair***	***High/ Low***	***Potentially feasible for VOC compounds; not effective for SVOCs and metals. Would require treatability testing.***
		Geochemical Fixation	Injection of organic sulfur compounds that react with metals to produce an insoluble complex that sorbs to soil	Technically implementable; treatability testing required	Potential	Fair	Moderate/ Moderate	Potentially feasible for inorganic contaminants; not effective for VOC/SVOC contaminants.
		Permeable Treatment Beds	***Install downgradient treatment trenches to remove or degrade contaminants***	***Technically implementable***	***Potential***	***Fair***	***High/Low to High***	***Wall would have to be constructed to a depth in excess of 100 feet, making it not cost competitive with other technologies treatment media may clog because of precipitation of inorganics. Although controllable with pH adjustment system, the additional complexity, high installation costs and potential need to replace the media makes this a poor choice for in situ treatment.***

TABLE 3-2
Technology/Process Option Evaluation – Groundwater
Feasibility Study
Martin Aaron Site

General Response Action	Remedial Technology	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
In Situ Treatment (cont.)	*Physical-Chemical (cont.)*	*Air Sparging*	*Inject air into groundwater*	*Technically implementable*	*Potential*	*Fair*	*Moderate/ Moderate*	*Not effective with removal of inorganics; subsurface heterogeneity may reduce effectiveness; depth of contamination may cause problems.*
	Biological	*Aerobic or Anaerobic*	*Enhance naturally-occurring degradation of contaminants with aerobic or anaerobic microbes*	*Technically implementable*	*Demonstrated*	*Poor*	*Moderate/ Moderate*	*Heterogeneity of aquifer, particularly the presence of clay stringers within the sands, makes adequate distribution of electron acceptors or organic substrates difficult. Also compounds requiring treatment include both aerobically and anaerobically degradable organics, thus increasing complexity.*
	Thermal	*Steam Injection/SVE*	*Inject steam, collect/treat gases/liquids*	*Technically implementable*	*Potential*	*Fair*	*High/High*	*Heterogeneity of aquifer, particularly the presence of silty sand glacial till layers within the sands, make adequate distribution of steam difficult. Also very expensive and is typically limited to NAPL removal applications.*
Collection	Extraction	Wells (horizontal and/or vertical)	Install vertical and/or horizontal wells and/or drains to extract contaminated GW	Technically implementable	Demonstrated	Good	Moderate/Low	Potentially feasible.
		Trenches	*Extract GW from trenches*	*Trench depth would be 50 to 100 feet, making this not technically feasible*	*Potential*	*Poor*	*High/ Moderate*	*Not feasible for excessive depths required.*
Ex Situ Treatment	Physical-Chemical	Air Stripping	Phase separation by forced air	Technically implementable	Less effective for semi-volatiles	Good	Low/ Moderate	Creates air emissions which may require treatment; less effective on semi-volatiles.

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TABLE 3-2
Technology/Process Option Evaluation – Groundwater
Feasibility Study
Martin Aaron Site

General Response Action	Remedial Technology	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
Ex Situ Treatment (cont.)	Physical-Chemical (cont.)	*Steam Stripping*	*Phase separation by steam and forced air*	*Technically implementable*	*Potential*	*Fair*	*High/High*	*Treatability testing required; more costly than air stripping, GAC or UV oxidation.*
		Adsorption	*Treat with GAC or other adsorptive media*	*Technically implementable*	*Demonstrated*	*Good*	*High/High*	*High iron concentration in groundwater may cause fouling. High costs are associated with replacement and O&M.*
		Oxidation	*Chemical, photo, or other oxidation*	*Technically implementable*	Demonstrated	*Good*	*Moderate/ High*	*Oxidation is costly and is not typically used for VOC removal.*
		Ion Exchange	*Treat with selected resins*	*Technically implementable for organics and inorganics*	*Potential*	*Fair*	*High/High*	*Treatability testing required; more costly than GAC and precipitation. Removal of inorganics to very low concentrations not necessary.*
		Reverse Osmosis	*Remove contaminants by forcing water through high pressure membrane*	*Difficult operation, not effective for organics*	Potential	*Poor*	*High/High*	*Costly technology when compared to other options. High O&M costs related to system operations.*
		Liquid/Liquid Extraction	*Extract contaminants based on solubility*	*Very high concentrations required*	Potential	*Poor*	*High/High*	*Costly technology when compared to other options. High O&M costs related to system operations.*
		Precipitation	Precipitate contaminants and filter water with low pressure medium (sand)	Technically implementable for inorganics present	Demonstrated	Good	Moderate/ High	Pretreatment by precipitation may be necessary before treating prior to discharge to surface water or POTW.
		Ultrafiltration	*Treat water with high pressure membrane*	*Not effective for low molecular weight organics*	Potential	*Poor*	*High/High*	*Costly technology when compared to other options. High O&M costs related to system operations.*
		Micro-filtration	*Treat water with high pressure membrane*	*Not effective for low molecular weight organics*	Potential	*Poor*	*High/High*	*Costly technology when compared to other options. High O&M costs related to system operations.*

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TABLE 3-2
Technology/Process Option Evaluation – Groundwater
Feasibility Study
Martin Aaron Site

General Response Action	Remedial Technology	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
Ex Situ Treatment (cont.)	*Physical-Chemical (cont.)*	*Freeze Crystallization*	*Inject refrigerant to separate contaminants*	*Very high concentrations of organics required; unproven technology*	*Potential*	*Poor*	*High/High*	*Costly technology when compared to other options. High O&M costs related to system operations.*
	Biological	*Aerobic*	*Degrade contaminants using aerobic microbes*	*Technically implementable*	*Potential*	*Good*	*High/High*	*Not cost effective compared to air stripping or GAC alone.*
	Thermal	*Evaporation*	*Remove contaminants by evaporation*	*Not effective for SVOCs*	Potential	*Poor*	*High/High*	*Not effective for SVOCs. Costly technology when compared to other options. High O&M costs related to system operations.*
		Rotary Kiln	*Combust GW in a heated horizontal rotary cylinder*	*Technically implementable*	*Potential*	*Fair*	*High/High*	*High cost, high energy requirements; treatability testing required.*
		Fluidized Bed	*Inject GW into hot bed of sand*	*Technically implementable*	*Potential*	*Fair*	*High/High*	*High cost, high energy requirements; treatability testing required.*
		Wet Air Oxidation	*High temperature/pressure thermal oxidation*	*Technically implementable*	*Potential*	*Fair*	*High/High*	*High cost, high energy requirements; treatability testing required.*
Discharge	Surface	*Storm Sewer System*	*Discharge treated water to Storm Sewer System*	*Technically implementable*	*Demonstrated*	*Fair to Good*	*Moderate/ High*	*Potentially feasible. Would require permitting. High arsenic concentrations in groundwater may require much higher treatment costs.*
		Publicly Owned Treatment Works (POTW)	Discharge untreated water to POTW	Technically implementable	Demonstrated	Fair to Good	Low/Moderate	Potentially feasible. Would require permitting.

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TABLE 3-2
Technology/Process Option Evaluation – Groundwater
Feasibility Study
Martin Aaron Site

General Response Action	Remedial Technology	Process Options	Description	Technical Implementability Screening Comments	Effectiveness	Technical and Administrative Implementability	Capital/ O&M Cost	Screening Comments
	Subsurface	Injection Wells	Pump treated GW back into subsurface	Technically implementable	Demonstrated	Fair	Moderate/ High	Higher capital cost and operational requirements than discharge to POTW because of additional treatment needed to remove metals to low levels. Would require permitting.
Discharge (cont.)	Subsurface (cont.)	***Infiltration***	***Discharge treated GW into infiltration galleries/trenches***	***Technically implementable***	***Demonstrated***	***Fair***	***Moderate/ High***	***Low water table and low transmissive soils may limit volume of water that can be infiltrated.***

Effectiveness is the ability to perform as part of a comprehensive alternative that can meet RAOs under conditions and limitations that exist at the site.

Implementability is the likelihood that the process could be implemented as part of the remedial action plan under the regulatory, technical, and schedule constraints.

Cost is for comparative purposes only, relative to other processes/technologies that perform similar functions.

Process options that have been screened out are italicized and bolded.

GW	GAC	Granular activated carbon	RAOs	Remedial Action Objectives
POTW	GW	Groundwater	TSDF	Treatment storage or disposal facility
HDPE	RCRA	Resource and Conservation Recovery Act	NA	Not applicable
VOCs	VOCs	Volatile organic contaminants	SVOCs	Semivolatile organic contaminants

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TABLE 4-1
Assembly of Soil Media Remedial Action Alternatives
Feasibility Study
Martin Aaron Site

Remedial Technologies or Process Options	Alternative 1- No Action	Alternative 2 Cap, and Institutional Controls	Alternative 3 Cap, Soil Vapor Extraction and In Situ Stabilization	Alternative 4 Cap, Excavation, Treatment and Offsite Disposal	Alternative 5 Cap, Soil Vapor Extraction, Excavation, Treatment and Offsite Disposal	Alternative 6 Total Excavation, Treatment and Offsite Disposal
Land Use Restrictions		X	X	X	X	
Building Demolition		X	X	X	X	X
Grading		X	X	X	X	X
4-inch and 12-inch Asphalt Cap		X	X	X	X	
In Situ Stabilization			X			
In Situ SVE			X		X	
Excavation				X	X	X
Ex Situ Stabilization				X	X	X
Offsite Disposal at Subtitle D Landfill				X	X	X

TABLE 4-2
Assembly of Groundwater Media Remedial Action Alternatives
Martin Aaron FS

Remedial Technologies or Process Options	Alternative 1 No Action	Alternative 2 MNA, and Institutional Controls	Alternative 3 Containment with Hydraulic Controls	Alternative 4 In Situ Geochemical Fixation and MNA	Alternative 5 Groundwater Collection and Treatment
Groundwater Use Restrictions		X	X	X	X
Monitored Natural Attenuation		X	X	X	
Monitoring of Groundwater			X	X	X
Containment with Hydraulic Controls			X		
In Situ Geochemical Fixation				X	
Groundwater Collection wells					X
Chemical Precipitation					X
Discharge to POTW			X		X

TABLE 4-3
Expected Groundwater Concentrations and POTW Discharge Limits
Martin Aaron Superfund Site Feasibility Study

Metal	MW 1S	MW 5S	MW 12S	MW 13S	MW 14S	MW 15S	MW 16S	MW 17S	MW 1M	MW 12M	MW 13M	MW 15M	MW 17M	MW 9S	MW 9D	MW 11S	MW 11M	MW 20S	MW 20M	Average ug/L	POTW Limit (mg/L)	Result
Arsenic	3700	938	31.1	5890	45.2	857	2060	564	20.2	21	125	1.5	2.6	**0.65**	**0.65**	**0.65**	**80.2**	**0.65**	**0.65**	754.69	1	Under Limit
Beryllium	**0.1**	0.36	0.23	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	0.36	0.33	**0.1**	0.22	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	0.15	Monitor Only	Under Limit
Cadmium	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	3.3	0.95	4.4	4.1	**0.1**	0.57	0.77	0.04	Under Limit
Chromium	5.7	19.4	3.6	9	2.4	13.4	11.8	2.2	19.4	0.6	0.6	0.6	0.6	1.9	0.64	13.4	**0.3**	1.3	**0.3**	5.64	2	Under Limit
Copper	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	8	**0.3**	**0.3**	**0.3**	**0.3**	1.2	16.6	3.3	**0.3**	12.4	1.3	4.7	2.69	1	Under Limit
Cyanide																**NA**				0.00	1	Under Limit
Lead	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	0.35	0.3	Under Limit
Mercury	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	0.05	0.01	Under Limit
Nickel	5.1	26.6	2.9	16.4	2.7	3.4	8.1	6.6	26.6	2.2	3.8	8.2	3.5	29.5	11	9.2	15.6	6.3	7.2	10.26	1	Under Limit
Silver	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	0.35	Monitor Only	Under Limit
Zinc	9.9	**0.35**	**0.35**	15.1	**0.35**	3.9	**0.35**	2190	**0.35**	5.2	279	18.8	10.6	567	293	1210	85.2	**0.35**	129	253.62	4	Under Limit
VOCs																						
Benzene	0.53	150	69	69	1.1	38	31	2	0.64	0.2	2.6	0.77	8.3	0.58	0.19	**0.25**	0.3	**0.25**	0.28	19.74		
Bromoform	0.27	**0.25**	**0.25**	**0.25**	**0.25**	0.46	0.3	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	0.64	0.24	**0.25**	**0.25**	**0.25**	**0.25**	0.28		
Chlorobenzene	**0.25**	2.3	1.8	**0.25**	0.53	1.3	**0.25**	**0.25**	0.5	0.37	0.22	**0.25**	**0.25**	0.44	0.37	**0.25**	1.1	**0.25**	0.43	0.60		
Chlorethane	**0.25**	3.9	**0.25**	**0.25**	**0.25**	3	5.3	**0.25**	**0.25**	**0.25**	0.33	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	0.86		
Chloroform	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	0.21	**0.25**	0.25		
Dichlorobenzene - 1,2	**0.25**	**0.25**	9.3	14	3.1	0.59	1.2	**0.25**	0.29	**0.25**	0.17	0.35	**0.25**	0.45	0.75	**0.25**	0.98	**0.25**	0.53	1.76		
Dichlorobenzene - 1,3	**0.25**	**0.25**	0.66	**0.25**	0.3	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	0.27		
Dichlorobenzene - 1,4	**0.25**	**0.25**	1.8	**0.25**	0.22	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	0.33		
Dichloroethane - 1,1	0.68	**0.25**	9	3.5	7.8	3.9	120	0.15	**0.25**	**0.25**	1.1	**0.25**	**0.25**	1.4	1.8	**0.25**	1.9	4	1.67	8.34		
Dichloroethane - 1,2	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	1.5	3.5	**0.25**	0.17	**0.25**	**0.25**	1.4	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	0.54		
Dichloroethylene - 1,1	**0.25**	**0.25**	0.41	**0.25**	0.54	**0.25**	0.47	**0.25**	0.22	**0.25**	**0.25**	0.16	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	0.28		
Ethylbenzene	**0.25**	27	33	45	0.58	0.65	2.4	0.16	**0.25**	**0.25**	0.4	**0.25**	2.4	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	6.00		
PCE	**0.25**	**0.25**	**0.2**	**0.55**	**0.25**	**0.25**	**0.75**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**1.5**	**0.78**	**0.25**	**0.15**	**0.25**	**0.25**	0.38		
Toluene	0.26	2.2	**0.25**	17	**0.25**	**0.25**	5.5	4.5	**0.25**	**0.25**	**0.25**	**0.25**	19	**0.25**	**0.25**	**0.25**	**0.25**	0.51	2.4	2.85		
Trichloroethane – 1,1,1	0.75	**0.25**	0.55	**0.25**	**0.25**	**0.25**	87	**0.25**	**0.25**	**0.25**	0.25	0.25	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	60	**0.25**	8.00		
TCE	**0.25**	**0.25**	5.5	1.1	11	1.4	1.8	**0.25**	1.3	**0.25**	**0.25**	**0.25**	**0.25**	1.7	1.3	1.2	0.45	1.6	0.51	1.61		
Vinyl Chloride	0.63	**0.25**	58	**0.25**	17	3	3.1	**0.25**	7.3	3.3	0.5	0.5	0.55	**0.25**	1	**0.25**	**0.25**	**0.25**	4.2	5.31		
Xylenes, Total	**0.25**	89	4.6	57	1.2	0.77	9	1.1	**0.25**	**0.25**	**0.25**	**0.25**	18	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	9.65		
BTEX																				38.24	1.5 mg/L	Under Limit
																			Total TTO ug/L [1]	**147.64**	**5.0 mg/L**	**Under Limit**

Note : Values in Bold are 1/2 of ND Values.
(1) TTO = Total Toxic Organic Concentration. Camden County Municipal Utilities Authority (CCMUA) VOC limit equals a TTO of 5.0 mg/l

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TABLE 5-1
Detailed Evaluation of Soil Remedial Alternatives
Martin Aaron Feasibility Study Report

Alternative Description: Criterion	Alternative S1—No Further Action	Alternative S2—Cap and Institutional Controls	Alternative S3—Cap, Soil Vapor Extraction and In Situ Stabilization	Alternative S4—Cap, Excavation, Treatment and Offsite Disposal	Alternative S5 – Cap, Soil Vapor Extraction, Excavation, Treatment and Offsite Disposal	Alternative S6 – Total Excavation, Treatment, and Offsite Disposal
1. Overall protection of human health and the environment.	▪ Arsenic and VOCs will continue to impact groundwater. ▪ Direct contact with soils could cause risks exceeding the 10-4 to 10-6 ELCR range. ▪ Erosion of soils exceeding direct contact PRGs will continue.	▪ Cap will prevent direct contact risks, leaching of contaminants, and erosion of contaminated soils. ▪ Institutional Controls will identify the area of soil contamination and minimize the potential for excavation of contaminated soil.	▪ Soil vapor extraction will eliminate leaching of VOCs to groundwater at concentrations that could cause MCL exceedance and also treat VOCs to concentrations below direct contact PRGs. ▪ In situ stabilization will treat arsenic impacted soils to eliminate unacceptable risks from direct contact and limit leaching to groundwater. ▪ Cap and institutional controls will prevent direct contact risks, leaching of contaminants, and erosion of contaminated soils.	▪ Excavation of VOC and arsenic soil source areas will limit leaching to groundwater. ▪ Cap will prevent direct contact risks, leaching of contaminants, and erosion of contaminated soils in areas outside of excavation area. ▪ Institutional Controls will identify the area of soil contamination and minimize the potential for excavation of contaminated soil.	▪ Excavation of arsenic soil source area will limit leaching of arsenic to groundwater. ▪ Soil vapor extraction will eliminate leaching of VOCs to groundwater at concentrations that could cause MCL exceedance and also treat VOCs to concentrations below direct contact PRGs. ▪ Cap will prevent direct contact risks, leaching of contaminants, and erosion of contaminated soils. ▪ Institutional Controls will identify the area of soil contamination and minimize the potential for excavation of contaminated soil.	▪ Excavation of all soils with concentrations exceeding PRGs will eliminate leaching to groundwater and direct contact risks to human health.
2. Compliance with ARARs[a]	▪ Soil would likely continue to cause exceedance of the Safe Drinking Water Act TCE MCL of 5 ug/L in groundwater. ▪ Monitoring of soil is not conducted so remedial time frame would remain unknown.	▪ Soil would likely continue to cause exceedance of groundwater PRGs due to continued leaching or TCE and arsenic. However ARAR would be met because monitoring would be conducted along with applicable institutional controls for groundwater.	▪ Meets ARAR for achieving MCLs in groundwater. TCE and arsenic are treated to eliminate leaching to groundwater in source areas. ▪ Would meet ARARs related to the Clean Air Act since emissions from vapor extraction system would be controlled as necessary.	▪ Meets ARAR for achieving MCLs in groundwater because soils resulting in leaching of TCE and arsenic to groundwater are removed. ▪ Would comply with ARARs for disposal of a hazardous waste (as applicable) or solid waste, depending on specific characterization.	▪ Meets ARAR for achieving MCLs in groundwater because soils resulting in leaching of TCE to groundwater are treated via vapor extraction. ▪ Would meet ARARs with respect to the Clean Air Act because emissions from vapor extraction and excavation would be controlled, as necessary. ▪ Would comply with ARARs for disposal of a hazardous waste (as applicable) or solid waste, depending on specific characterization.	▪ Meets ARAR for achieving MCLs in groundwater because soils resulting in leaching of TCE and arsenic to groundwater are removed. ▪ Would meet ARARs with respect to the Clean Air Act because emissions from excavation would be controlled, as necessary. ▪ Would comply with ARARs for disposal of a hazardous waste (as applicable) or solid waste, depending on specific characterization.
3. Long-term effectiveness and permanence						
(a) Magnitude of residual risks	▪ Risk would slowly diminish over several decades as VOC soil contaminants naturally attenuate to concentrations less than PRGs.	▪ Long-Term residual risks would continue for contaminants left in place. Soil contamination would remain relatively unchanged for decades because cap eliminates moisture necessary for biodegradation and cap prevents leaching that otherwise reduces soil COC concentrations.	▪ Once treatment of VOCs and arsenic in source areas is completed, leaching to groundwater would be greatly reduced. ▪ Long-term risks would remain for areas outside of active treatment zones (vapor extraction and stabilization areas) that would persist. However residual risk is a much lower order of magnitude risk.	▪ Once VOC and arsenic soil source areas are excavated and disposed of offsite, leaching to groundwater would be greatly reduced. ▪ Remaining soil contamination under cap would be a much lower order of magnitude risk after excavation.	▪ Once vapor treatment of VOCs and excavation of arsenic source areas are completed, leaching to groundwater would be greatly reduced. ▪ Remaining soil contamination under cap would be a much lower order of magnitude risk after excavation and vapor treatment.	▪ All long-term risks to human health (through direct contact or inhalation) and the environment (through elimination of leaching to groundwater) would be eliminated. ▪ No soil contamination over PRGs would remain.
(b) Adequacy and reliability of controls	▪ Not applicable.	▪ Cap is adequate and reliable in preventing direct contact, infiltration, and erosion of soil with concentrations exceeding PRGs. ▪ Deed restrictions are necessary to prevent intrusive activities into impacted soils and spreading of contaminated soil. They are considered adequate and reliable.	▪ Vapor extraction is typically an effective technology within the geology and depths targeted at the site. ▪ In situ stabilization has been proven as an adequate and reliable control for arsenic impacted soils. ▪ The cap and institutional controls are adequate and reliable in preventing direct contact with impacts soils.	▪ Excavation, offsite treatment, and disposal is adequate and reliable in eliminating future leaching to groundwater. ▪ Cap is adequate and reliable in preventing direct contact, infiltration, and erosion of soil with concentrations exceeding PRGs.	▪ Excavation, offsite treatment, and disposal of arsenic impacted soils and vapor extraction of VOC impacted soils is adequate and reliable in eliminating future leaching to groundwater. ▪ Cap is adequate and reliable in preventing direct contact, infiltration, and erosion of soil with concentrations exceeding PRGs for areas outside of vapor treatment or excavation areas.	▪ No controls necessary since all soils with COCs over the PRGs are removed.

TABLE 5-1
Detailed Evaluation of Soil Remedial Alternatives
Martin Aaron Feasibility Study Report

Alternative Description: Criterion	Alternative S1—No Further Action	Alternative S2—Cap and Institutional Controls	Alternative S3—Cap, Soil Vapor Extraction and In Situ Stabilization	Alternative S4—Cap, Excavation, Treatment and Offsite Disposal	Alternative S5 – Cap, Soil Vapor Extraction, Excavation, Treatment and Offsite Disposal	Alternative S6 – Total Excavation, Treatment, and Offsite Disposal
4. Reduction of toxicity, mobility, or volume through treatment						
(a) Treatment process used	▪ Not applicable.	▪ Natural attenuation for VOCs only. ▪ No reduction of metals contaminated soils.	▪ Soil vapor extraction used to remove TCE from soil. Catalytic oxidation used to destroy VOC in vapors. ▪ In situ stabilization reduces the mobility of arsenic in soils to eliminate leaching.	▪ The excavated soils would be treated via solidification prior to disposal, as necessary, to meet LDR requirements.	▪ Vapor extraction is used to treat VOC impacted soils. Excavated arsenic contaminated soils would be solidified, as necessary prior to disposal.	▪ The excavated soils would be treated via solidification prior to disposal, as necessary, to meet LDR requirements.
(b) Degree and quantity of TMV reduction	▪ Not applicable	▪ Natural attenuation for VOCs would take decades. ▪ Metals impacted soils not treated.	▪ Vapor extraction expected to remove and destroy approximately 7,000 pounds of VOCs via offgas treatment. ▪ Approximately 100,000 pounds of arsenic are immobilized through in situ treatment.	▪ An estimated 3200 CY of arsenic contaminated soil would be treated via solidification (75% of arsenic soil).	▪ Vapor extraction expected to remove and destroy approximately 7,000 pounds of VOCs via offgas treatment. ▪ An estimated 3200 CY of arsenic contaminated soil would be treated via solidification (75% of arsenic soil).	▪ An estimated 3200 CY of arsenic contaminated soil would be treated via solidification (75% of arsenic soil).
(c) Irreversibility of TMV reduction	▪ Not applicable	▪ Not applicable since no TMV reduction seen.	▪ TCE removed is destroyed through the catalytic oxidation process. ▪ Immobilization of arsenic impacted soils through stabilization is reversible but unlikely because soil will be disposed in a lined and capped solid waste landfill.	▪ Immobilization of arsenic impacted soils through stabilization is reversible but unlikely because soil will be disposed in a lined and capped solid waste landfill.	▪ TCE removed is destroyed through the catalytic oxidation process. ▪ Immobilization of arsenic impacted soils through stabilization is reversible but unlikely because soil will be disposed in a lined and capped solid waste landfill.	▪ Immobilization of arsenic impacted soils through stabilization is reversible but unlikely because soil will be disposed in a lined and capped solid waste landfill
(d) Type and quantity of treatment residuals	▪ None, because no treatment included.	▪ Not applicable.	▪ Additional volume of soil is generated through in situ stabilization.	▪ An estimated 3200 CY of arsenic contaminated soil would be treated via solidification. A 20 percent increase in volume is typical.	▪ An estimated 3200 CY of arsenic contaminated soil would be treated via solidification. A 20 percent increase in volume is typical.	▪ An estimated 3200 CY of arsenic contaminated soil would be treated via solidification. A 20 percent increase in volume is typical.
(e) Statutory preference for treatment as a principal element	▪ Preference not met for soil because no treatment included.	▪ Preference not met for soil because no treatment included.	▪ Preference is met for soil source areas.	▪ Preference is met for soil source areas.	▪ Preference is met for soil source areas.	▪ Preference is met for soil source areas.
5. Short-term effectiveness						
(a) Protection of workers during remedial action	▪ No remedial construction, so no risks to workers.	▪ Minimal risks to workers during cap construction and soil sampling activities.	▪ Minimal risks to workers during vapor extraction and soil sampling. Risks are slightly higher to workers during in situ stabilization due to potential exposure during mixing. Proper health and safety procedures would be included in the Health and Safety Plan for field actions.	▪ Excavation soil could result in potential exposure of workers via TCE inhalation. Proper health and safety procedures such as air monitoring and use of Level C respirator protection would be included in the Health and Safety Plan for construction.	▪ Excavation of arsenic contaminated soil will involve minimal risk to workers if proper health and safety procedures are followed. ▪ Minimal risks to workers during vapor extraction and soil sampling.	▪ Excavation soil could result in potential exposure of workers via TCE inhalation. Proper health and safety procedures such as air monitoring and use of Level C respirator protection would be included in the Health and Safety Plan for construction.

TABLE 5-1
Detailed Evaluation of Soil Remedial Alternatives
Martin Aaron Feasibility Study Report

Alternative Description: Criterion	Alternative S1—No Further Action	Alternative S2—Cap and Institutional Controls	Alternative S3—Cap, Soil Vapor Extraction and In Situ Stabilization	Alternative S4—Cap, Excavation, Treatment and Offsite Disposal	Alternative S5 – Cap, Soil Vapor Extraction, Excavation, Treatment and Offsite Disposal	Alternative S6 – Total Excavation, Treatment, and Offsite Disposal
(b) Protection of community during remedial action	▪ No remedial construction, so no short-term risks to community.	▪ Minimal risks to the community during cap construction or soil sampling.	▪ Air emissions from vapor extraction system would be controlled to the extent required by the air emissions permit. It is assumed this would require treatment by catalytic oxidation. Dust emissions are expected during in situ stabilization of about 8,400 cy of soil. Air monitoring and control measures would be implemented to control emissions and protect the community. SVE would be conducted prior to stabilization for the portion of soils that contains VOCs and arsenic so only minimal VOCs would be emitted during stabilization.	▪ There are significant risks to the community during excavation, due to the close proximity of residents in the area and limited traffic access for trucks hauling impacted soils.. Dust emissions are expected during excavation of about 8,400 CY of arsenic impacted soil. VOC and dust emissions are expected during excavation of about 10,600 CY of VOC impacted soils. Air monitoring and control measures would be implemented to control emissions and protect the community. ▪ There are short-term safety-related risks to community due to the number of trucks (approximately 1,600) used to transport excavated soils.	▪ There are risks to the community during excavation, due to the close proximity of residents in the area and limited traffic access for trucks hauling impacted soils.. Dust emissions are expected during excavation of about 8,400 cy of arsenic impacted soil. Air monitoring and control measures would be implemented to control emissions and protect the community. ▪ There are short-term safety-related risks to community due to the number of trucks (approximately 700) used to transport excavated soils. ▪ Air emissions from vapor extraction system would be controlled to the extent required by the air emissions permit. It is assumed this would require treatment by catalytic oxidation.	▪ There are significant risks to the community during excavation, due to the close proximity of residents in the area, limited traffic access for trucks hauling impacted soils, and the volume of soil to be excavated. VOC and dust emissions are expected during excavation of about 10,600 CY of VOC impacted soils Dust emissions are expected during excavation of the remaining 45,000 CY of soil. Air monitoring and control measures would be implemented to control emissions and protect the community. ▪ There are safety-related risks to community due to the time required and number of trucks (about 4,800) used to transport excavated soils.
(c) Environmental impacts of remedial action	▪ No remedial construction, so no environmental impacts from remedial action.	▪ Minimal risks to the environment during cap construction.	▪ Minimal risks to the environment during vapor extraction and in situ stabilization. Proper air emission controls would be required to eliminate potential unabated air emissions. Silt fencing would be used to eliminate soil erosion runoff during in situ stabilization.	▪ Storm water re-routing would be required during and after excavation. ▪ Environmental impacts will likely be limited to emissions of contaminants in dust and some migration via erosion. The impacts can be controlled through use of dust suppressants and implementation of an erosion control plan.	▪ Minimal risks to the environment during vapor extraction and in situ stabilization. Proper air emission controls would be required to eliminate potential unabated air emissions. ▪ Environmental impacts will likely be limited to emissions of contaminants in dust and some migration via erosion. The impacts can be controlled through use of dust suppressants and implementation of an erosion control plan.	▪ Environmental impacts will likely be limited to emissions of contaminants in dust and some migration via erosion. The impacts can be controlled through use of dust suppressants and implementation of an erosion control plan.
(d) Time until RAOs are achieved	▪ The RAOs to prevent further leaching of arsenic and VOCs to groundwater at concentrations that result in exceedance of the MCL would not be met	▪ The RAOs to prevent further leaching of arsenic and VOCs to groundwater at concentrations that result in exceedance of the PRGs would be met following cap construction.	▪ Vapor extraction of VOC groundwater source area will be completed within approximately 2 years. ▪ In situ stabilization will occur immediately after injection of mixture and allowed to cure.	▪ The excavation activities would immediately eliminate the highest concentrations of VOCs and arsenic in soil. ▪ The RAOs to prevent further leaching of arsenic and VOCs to groundwater at concentrations that result in exceedance of the PRGs would be met following cap construction.	▪ Excavation of arsenic impacted soils would immediately eliminate leaching to groundwater. ▪ Vapor extraction is expected to operate for 2 years. ▪ The RAOs to prevent further leaching of arsenic and VOCs to groundwater at concentrations that result in exceedance of the PRGs would be met following cap construction.	▪ RAOs are immediately achieved after excavation and backfilling with clean fill material.
6.Implementability						
(a) Technical feasibility	▪ No impediments.	▪ No impediments. ▪ Cap will also allow for storm water re-routing, which currently is an issue at the site.	▪ The main technical challenge is to ensure proper mixing and delivery of in situ stabilization agent to solidify arsenic in soils.	▪ The main technical challenge is to ensure proper monitoring and capture of any fugitive vapors during excavation.	▪ The main technical challenge is to ensure proper monitoring and capture of any fugitive vapors during excavation.	▪ The main technical challenge is to ensure proper monitoring and capture of any fugitive vapors during excavation.
(b) Administrative feasibility	▪ No impediments.	▪ Future land use may require no engineering or institutional controls be present. ▪ May be less administratively feasible on adjacent properties.	▪ No impediments.	▪ No impediments.	▪ No impediments.	▪ May be difficult to implement because of the need for coordination with multiple property owners.
(c) Availability of services and materials	▪ None needed.	▪ Services and materials are available.	▪ Services and materials are available.	▪ Services and materials are available.	▪ Services and materials are available.	▪ Services and materials are available.

Comment [KN1]: Dave Nisula: What about emissions?

TABLE 5-1
Detailed Evaluation of Soil Remedial Alternatives
Martin Aaron Feasibility Study Report

Alternative Description: Criterion	Alternative S1—No Further Action	Alternative S2—Cap and Institutional Controls	Alternative S3—Cap, Soil Vapor Extraction and In Situ Stabilization	Alternative S4—Cap, Excavation, Treatment and Offsite Disposal	Alternative S5 – Cap, Soil Vapor Extraction, Excavation, Treatment and Offsite Disposal	Alternative S6 – Total Excavation, Treatment, and Offsite Disposal
7. Total Cost						
Direct Capital Cost	▪ $0	▪ $3,420,000	▪ $3,570,000	▪ $5,500,000	▪ $4,700,000	▪ $11,000,000
Annual O&M Cost	▪ $0	▪ $24,500	▪ $133,000	▪ $14,700	▪ $133,000	▪ $0
Total Present Worth Cost	▪ $0	▪ $3,860,000	▪ $4,060,000	▪ $5,780,000	▪ $5,190,000	▪ $11,000,000

TABLE 5-2
Detailed Evaluation of Groundwater Media Alternatives
Martin Aaron Site, Feasibility Study Report

Alternative Description: Criterion	Alternative G1- No Further Action	Alternative G2- MNA and Institutional Controls	Alternative G3- Containment with Hydraulic Controls	Alternative G4- In Situ Geochemical Fixation and MNA	Alternative G5 – Groundwater Collection and Treatment
1. Overall Protection of Human Health and the Environment.	▪ TCE, cis-1,2 DCE, VC and arsenic will continue to persist in groundwater at concentrations exceeding the PRGs. ▪ There is a potential for human exposure to contaminated groundwater since institutional controls are not a part of this alternative, even through groundwater is not used for potable purposes in the area.	▪ TCE, cis 1,2 DCE , VC and arsenic will continue to persist in groundwater at concentrations exceeding the PRGs. ▪ The potential for human exposure to contaminated groundwater will be minimized through institutional controls. Under this alternative, the institutional controls will be required to be in effect for decades. ▪ Future use of the groundwater supply will be limited due to the institutional controls.	▪ This alternative collects impacted groundwater along the downgradient portion of the plume to ensure no continued migration of contaminants exceeding PRGs. It also extracts groundwater near the source area to reduce the time to achieve PRGs. ▪ The potential for human exposure to contaminated groundwater will also be minimized through institutional controls. Under this alternative, the institutional controls will be required to be in effect for decades, though less time than Alternatives 1 and 2.	▪ This alternative reduces the concentrations of arsenic in groundwater to below the MCL in the areas with the highest concentrations (over 750 mg/L), thus reducing the timeframe to meet the PRGs. ▪ MNA will be utilized for the remainder of the VOC plume which will take decades to achieve PRGs. ▪ The potential for human exposure to contaminated groundwater will be minimized through institutional controls. Under this alternative, the institutional controls will be required to be in effect for decades, though less time than Alternatives 1 and 2. ▪ In situ treatment of arsenic in groundwater, which is the largest mass of contaminants in groundwater, is expected to reduce the overall timeframe to meet PRGs.	▪ This alternative actively reduces the concentrations of TCE and arsenic in groundwater over the majority of the plume, thus reducing the timeframe to meet the PRGs. ▪ The potential for human exposure to contaminated groundwater will be minimized through institutional controls. Under this alternative, the institutional controls will be required to be in effect for decades, though less time than the other alternatives.
2. Compliance with ARARs[a]	▪ Would meet ARARs when TCE, cis-1,2 DCE, VC and arsenic contamination in groundwater do not result in concentrations that exceed groundwater PRGs. Under this alternative, this would take decades and may persist indefinitely (for arsenic).	▪ Would meet ARARs when TCE, cis 1,2 DCE , VC and arsenic contamination in groundwater do not result in concentrations that exceed groundwater PRGs. Under this alternative, this would take decades and may persist indefinitely (for arsenic).	▪ Would meet ARARs when TCE, cis 1,2 DCE , VC and arsenic contamination in groundwater do not result in concentrations that exceed groundwater PRGs.	▪ Would meet ARARs when TCE, cis 1,2 DCE , VC and arsenic contamination in groundwater do not result in concentrations that exceed groundwater PRGs. Nearly 80 percent of arsenic is expected to be treated immediately after injection process. The remaining mass of arsenic and VOCs would remain above PRGs for decades.	▪ Would meet ARARs when TCE, cis 1,2 DCE , VC and arsenic contamination in groundwater does not result in concentrations that exceed groundwater PRGs. Pumping is expected to continue for 10 years under this alternative. ▪ Air treatment may be necessary to meet ARARs associated with the Clean Air Act.
3. Long-Term Effectiveness and Permanence					
(a) Magnitude of residual risks	▪ No significant change in risk because no action taken. Reduction in risk relating to TCE, cis 1,2 DCE, VC and arsenic contamination in groundwater exceeding groundwater PRGs would occur slowly over decades.	▪ No significant change in risk because no action taken. Reduction in risk relating to TCE, cis 1,2 DCE , VC and arsenic contamination in groundwater exceeding groundwater PRGs would occur slowly over decades.	▪ Since this option is for more passive control of the groundwater plume rather than active collection and treatment, residual risks will remain for a longer period of time, but will meet the PRGs sooner than alternatives G1 or G2.	▪ Residual risks related to arsenic in groundwater will be eliminated once the concentrations of arsenic are reduced to below the PRGs through geochemical fixation. Residual risks related to VOCs in groundwater once MNA remediates the downgradient portion of the plumes to below PRGs. However MNA will take decades.	▪ Residual risks will be eliminated once the groundwater collection system remediates groundwater over the entire plume. This is anticipated to take 10 years.
(b) Adequacy and reliability of controls	▪ Not applicable.	▪ Requires reliance on institutional controls for groundwater. These controls will be necessary for decades under this alternative.	▪ Requires reliance on institutional controls for groundwater. These controls will be necessary for decades under this alternative.	▪ Requires reliance on institutional controls for groundwater during MNA. These controls will be necessary for decades under this alternative.	▪ Requires reliance on institutional controls for groundwater during remediation.
4. Reduction of Toxicity, Mobility, or Volume through Treatment					
(a) Treatment process used	▪ Not applicable.	▪ Natural attenuation only.	▪ Groundwater collection along the downgradient portion of the plume for discharge to the POTW. ▪ VOCs would be treated at POTW primarily through volatilization and adsorption. Arsenic removal at POTW would occur primarily through precipitation and adsorption.	▪ In situ geochemical fixation through the injection of calcium polysulfide to precipitate arsenic from groundwater. ▪ MNA will also reduce concentrations in groundwater, but over decades.	▪ Will extract groundwater throughout the plume. ▪ Arsenic removed through chemical precipitation ▪ VOCs would be treated at POTW primarily through volatilization and adsorption.

TABLE 5-2
Detailed Evaluation of Groundwater Media Alternatives
Martin Aaron Site, Feasibility Study Report

Alternative Description: Criterion	Alternative G1- No Further Action	Alternative G2- MNA and Institutional Controls	Alternative G3- Containment with Hydraulic Controls	Alternative G4- In Situ Geochemical Fixation and MNA	Alternative G5 – Groundwater Collection and Treatment
(c) Environmental impacts of remedial action	▪ No remedial construction, so no environmental impacts.	▪ No remedial construction, so no environmental impacts.	▪ No environmental impacts during construction or operation of the system.	▪ Regional water supplies are unlikely to be adversely impacted from the calcium polysulfide injection because the injection will be only within the low permeability shallow Upper PRM groundwater and the calcium polysulfide is not expected to migrate appreciable beyond the injection area. ▪ The pH of groundwater will be increased temporarily during the injection process. ▪ Silt fencing will be used to control erosion during the 6 months of onsite soil mixing.	▪ No environmental impacts during construction or operations of the system.
(d) Time until RAOs are achieved	▪ Long-term attainment of groundwater RAOs will take decades to meet under this alternative. ▪ Other remaining RAOs are not met.	▪ Long-term attainment of groundwater RAOs will take decades to meet under this alternative.	▪ The pumping system would operate for 10 to 20 years to reduce concentrations to levels acceptable for natural attenuation. ▪ PRGs may be difficult to attain for the shallow Upper PRM groundwater because of the thin saturated thickness and low permeability of the soil. ▪ Decades would be required to meet PRGs using MNA for the remainder of the plume.	▪ Arsenic in groundwater will be treated immediately (within days) of injection. It is not anticipated that multiple injections will be required. ▪ Decades would be required to meet PRGs using MNA for the remainder of the plume.	▪ PRGs may be difficult to attain for the shallow Upper PRM groundwater because of the thin saturated thickness and low permeability of the soil. ▪ The RAO for treating groundwater to below the PRGs will be achieved in approximately 10 years for the remainder of the aquifers.
6. Implementability					
(a) Technical feasibility	▪ No impediments.	▪ No impediments	▪ No impediments.	▪ Treatability testing to establish effectiveness and dosage of chemical needed for arsenic precipitation will be necessary.	▪ No impediments.
(b) Administrative feasibility	▪ No impediments.	▪ No impediments.	▪ The substantive requirements for discharge to the POTW will be met, but no impediments are expected.	▪ Underground injection permit will be necessary to obtain from New Jersey.	▪ The substantive requirements for discharge to the POTW will be met, but no impediments are expected.
(c) Availability of services and materials	▪ None needed.	▪ None needed.	▪ Necessary engineering services and materials readily available for installation and operation of system.	▪ Necessary engineering services and materials readily available for installation and operation of system. Calcium polysulfide materials are available from vendors in Minnesota.	▪ Necessary engineering services and materials readily available for installation and operation of system.
7. Total Cost	Total Capital Cost $0 Annual O&M Cost $0 Total Periodic Cost $0 Total Present Worth Cost $0	Total Capital Cost $15,000 Annual O&M Cost $26,000 Total Periodic Cost $150,000 Total Present Worth Cost $550,000	Total Capital Cost $300,000 Annual O&M Cost $187,000 Total Periodic Cost $150,000 Total Present Worth Cost $2,900,000	Total Capital Cost $1,200,000 Annual O&M Cost $26,000 Total Periodic Cost $150,000 Total Present Worth Cost $1,700,000	Total Capital Cost $1,300,000 Annual O&M Cost $680,000 Total Periodic Cost $30,000 Total Present Worth Cost $6,100,000

TABLE 5-2
Detailed Evaluation of Groundwater Media Alternatives
Martin Aaron Site, Feasibility Study Report

Alternative Description: Criterion	Alternative G1- No Further Action	Alternative G2- MNA and Institutional Controls	Alternative G3- Containment with Hydraulic Controls	Alternative G4- In Situ Geochemical Fixation and MNA	Alternative G5 – Groundwater Collection and Treatment
(b) Degree and quantity of TMV reduction through Treatment	▪ Not applicable.	▪ Natural attenuation would take decades.	▪ Would remove approximately 2 pounds of the estimated 9 pounds of VOCs in first year of operation with diminishing removal rates after the first year. ▪ The majority of the dissolved arsenic in the shallow Upper PRM may not be removed because of the difficulty in flushing the low permeability soil in a relatively thin saturated thickness.	▪ Approximately 80 percent (or 32 pounds) of arsenic will be treated using the in situ geochemical fixation. ▪ The VOCs (9 pounds) will be treated using natural attenuation.	▪ Would remove nearly all the estimated 9 pounds of VOCs. The majority of the dissolved arsenic in the shallow Upper PRM may not be removed because of the difficulty in flushing the low permeability soil in a relatively thin saturated thickness.
(c) Irreversibility of TMV reduction	▪ Not applicable.	▪ Natural degradation of VOCs is irreversible. ▪ Arsenic would be removed by precipitation as the shallow Upper PRM aquifer slowly becomes aerobic over many decades. This natural process is reversible if the aquifer were to return to an anaerobic reducing environment. This is considered unlikely however because it would require release of a substantial amount of organic substrate to the aquifer.	▪ Irreversible because impacted groundwater is removed and discharged to the POTW. ▪ Natural degradation of the VOCs in the remainder of the plume is irreversible.	▪ In situ geochemical fixation of arsenic in groundwater is irreversible, unless major groundwater conditions (such as pH change to near acidic conditions) occurs and mobilizes arsenic. ▪ Natural degradation of the remainder of the VOCs in the plume is irreversible.	▪ Groundwater chemical precipitation treatment is irreversible because precipitated arsenic is removed as a sludge, solidified and disposed as a solid or hazardous waste in a landfill. ▪ Natural degradation of the remainder of the plume is irreversible.
(d) Type and quantity of treatment residuals	▪ None, because no treatment included.	▪ Natural attenuation of arsenic will result in precipitated arsenic in the shallow Upper PRM aquifer.	▪ None generated onsite because no treatment is necessary prior to discharge to POTW. ▪ VOCs and arsenic treated at POTW will generate an insignificant amount of residuals.	▪ An estimated 32 pounds of precipitated arsenic will remain in situ as a treatment residual in the shallow groundwater. ▪ None generated under natural attenuation for the remainder of the plume.	▪ Arsenic precipitation will be generated through the ex situ treatment of generated groundwater. ▪ None generated under natural attenuation for the remainder of the plume.
(e) Statutory preference for treatment as a principal element	▪ Preference not met for groundwater because no treatment included.	▪ Preference not met for groundwater because no treatment beyond natural attenuation included.	▪ Preference met for groundwater because treatment at POTW is included.	▪ Preference met for groundwater because groundwater injection fixates arsenic.	▪ Preference met for groundwater because treatment at POTW is included.
5. Short-Term Effectiveness					
(a) Protection of workers during remedial action	▪ No remedial construction, so no risks to workers.	▪ No remedial construction, so no risks to workers.	▪ Minimal risks to workers during construction or operation of the pumping system. Proper health and safety requires must be followed during construction and operation.	▪ Calcium polysulfide has a high pH (11) and risks to workers could occur if proper health and safety requirements are not adhered to during handling and injection. Proper health and safety protection from VOC emissions during soil mixing would also be important. ▪ No risks to workers during MNA monitoring.	▪ Minimal risks to workers during construction or operation of the pumping system. Proper health and safety requires must be followed during construction and operation.
(b) Protection of community during remedial action	▪ No remedial construction, so no short-term risks to community.	▪ No remedial construction, so no short-term risks to community.	▪ Minimal risks to the community during construction and operation of the system.	▪ Potential risks to the community during the injection process of calcium polysulfide would be closely monitored. There would be considerable soil mixing (64,000 CY) onsite over a 6 month construction period that will generate noise and emissions of VOCs and dust. Emission controls will be implemented to minimize VOCs and dust generation. Truck traffic is expected to be minimal since the materials can be transported in bulk via tanker truck.	▪ Minimal risks to community during construction and operation of the system.. For noise, equipment will be housed within a building and will designed to reduce noise levels

Figures

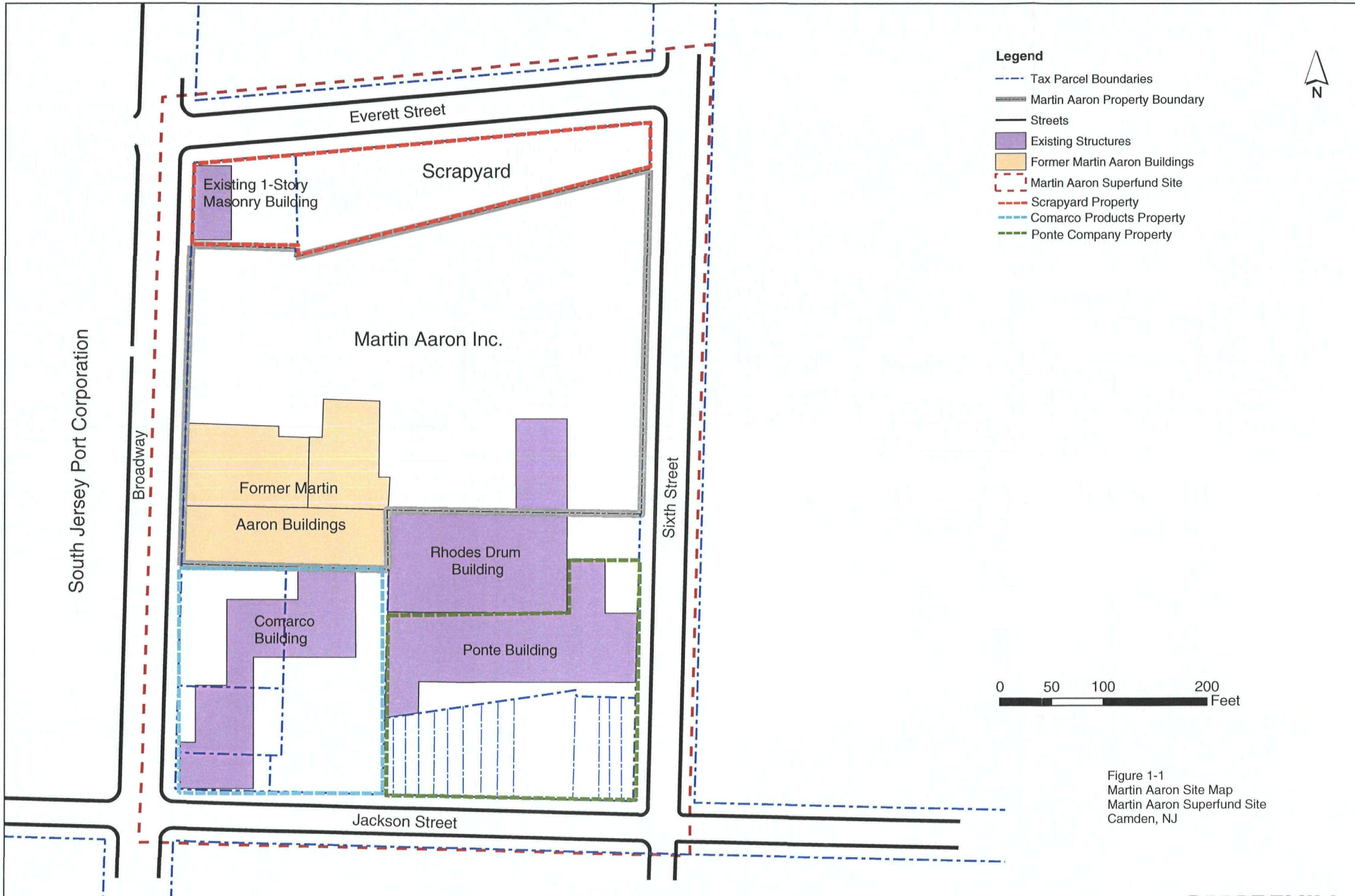

Figure 1-1
Martin Aaron Site Map
Martin Aaron Superfund Site
Camden, NJ

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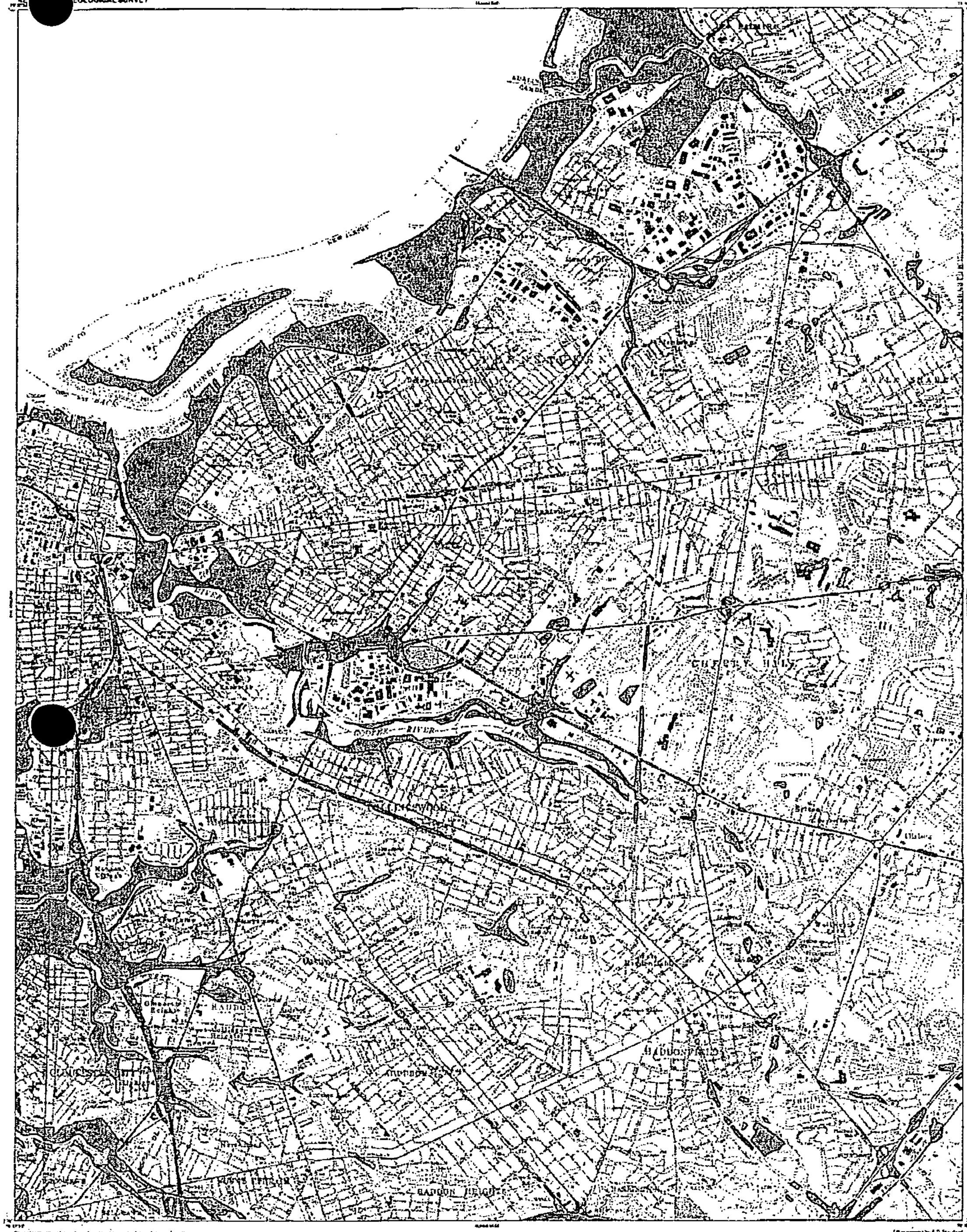


EXPLANATION

The "Brownfield and Contaminated Site Remediation Act" (N.J.S.A. 58:10B-1 et seq.) requires the Department of Environmental Protection to map regions of the state where large areas of historic fill exist and make this information available to the public. This map shows areas of historic fill covering more than approximately 5 acres. For the purposes of this map, historic fill is non-indigenous material placed on a site in order to raise the topographic elevation of the site. No representation is made as to the composition of the fill or presence of contamination in the fill. Some areas mapped as fill may contain chemical-production waste or ore-processing waste that exclude them from the legislative definition of historic fill.

Fill was mapped from stereo aerial photography taken in March 1979, supplemented in places by planimetric aerial photography taken in the spring of 1991 and 1992. Additional areas of fill were mapped by comparing areas of swamp, marsh, and floodplain shown on archival topographic and geologic maps on file at the N. J. Geological Survey, dated between 1840 and 1910, to their modern extent. In a few places, fill was mapped from field observations and from drillers' logs of wells and borings.

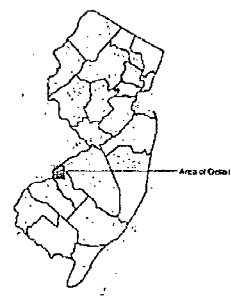
Most urban and suburban areas are underlain by a discontinuous layer of excavated indigenous soil mixed with varying amounts of non-indigenous material. This material generally does not meet the definition of historic fill and is not depicted on this map. Also, there may be historic fills that are not detectable on aerial photography or by archival map interpretation and so are not shown on this map, particularly along streams in urban and suburban areas.

Use of the maps related to the Technical Rules, N.J.A.C. 7:26E

This map is provided for informational purposes only. The use of this map as the only source of information regarding the presence of historic fill at a site does not fulfill the diligent inquiry requirements of the Preliminary Assessment set forth at, N.J.A.C. 7:26E-3.1(c). This map may be used as one source of information to fulfill the requirements of the Site Investigation at, N.J.A.C. 7:26E-3.12. This map is not intended to fulfill the Remedial Investigation requirements associated with historic fill at, N.J.A.C. 7:26E-4.6(b).

Historic Fill

Non-Fill Area



HISTORIC FILL OF THE CAMDEN QUADRANGLE

2004

400093

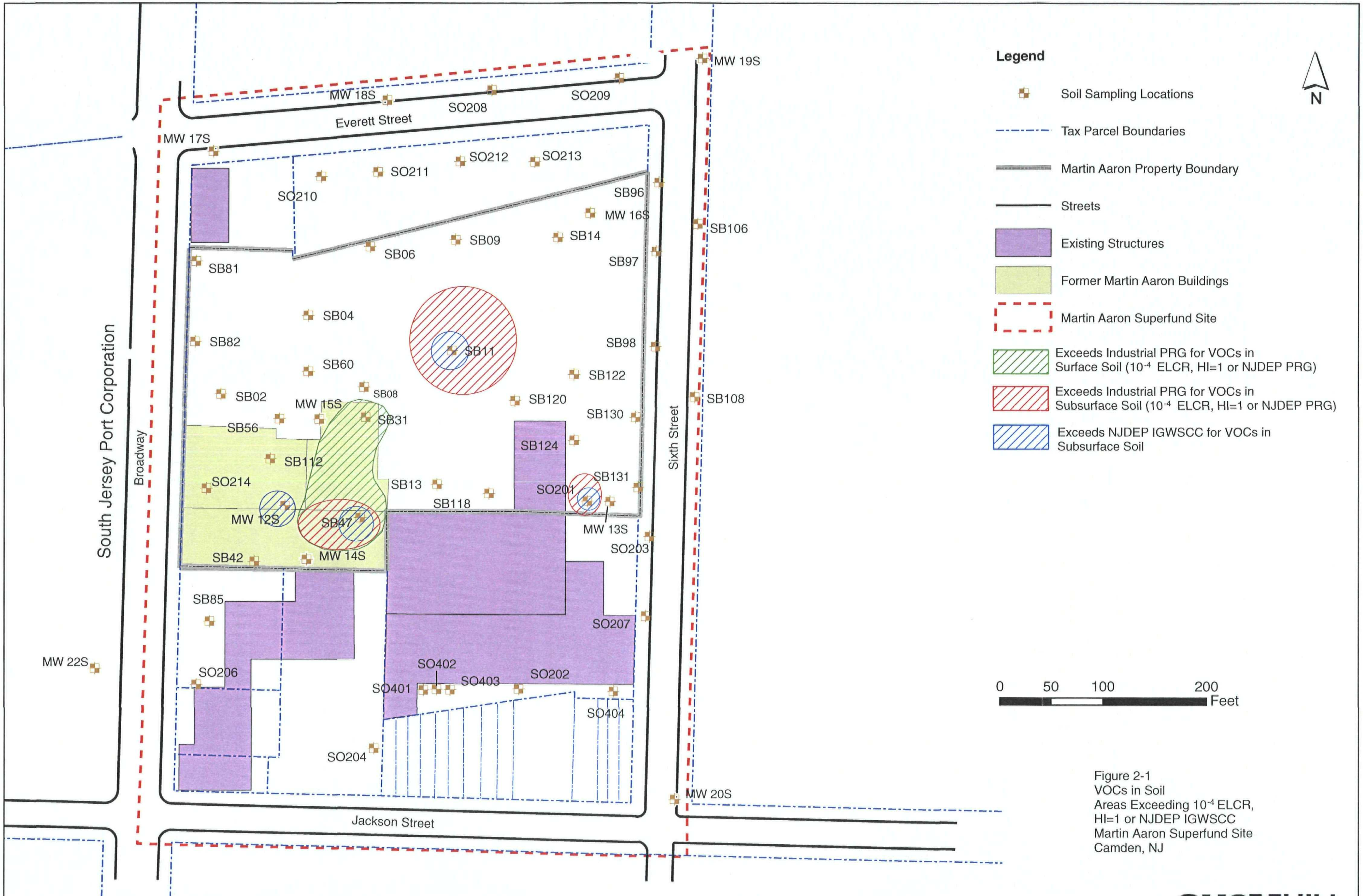


Figure 2-1
VOCs in Soil
Areas Exceeding 10^{-4} ELCR,
HI=1 or NJDEP IGWSCC
Martin Aaron Superfund Site
Camden, NJ

CH2MHILL

400094

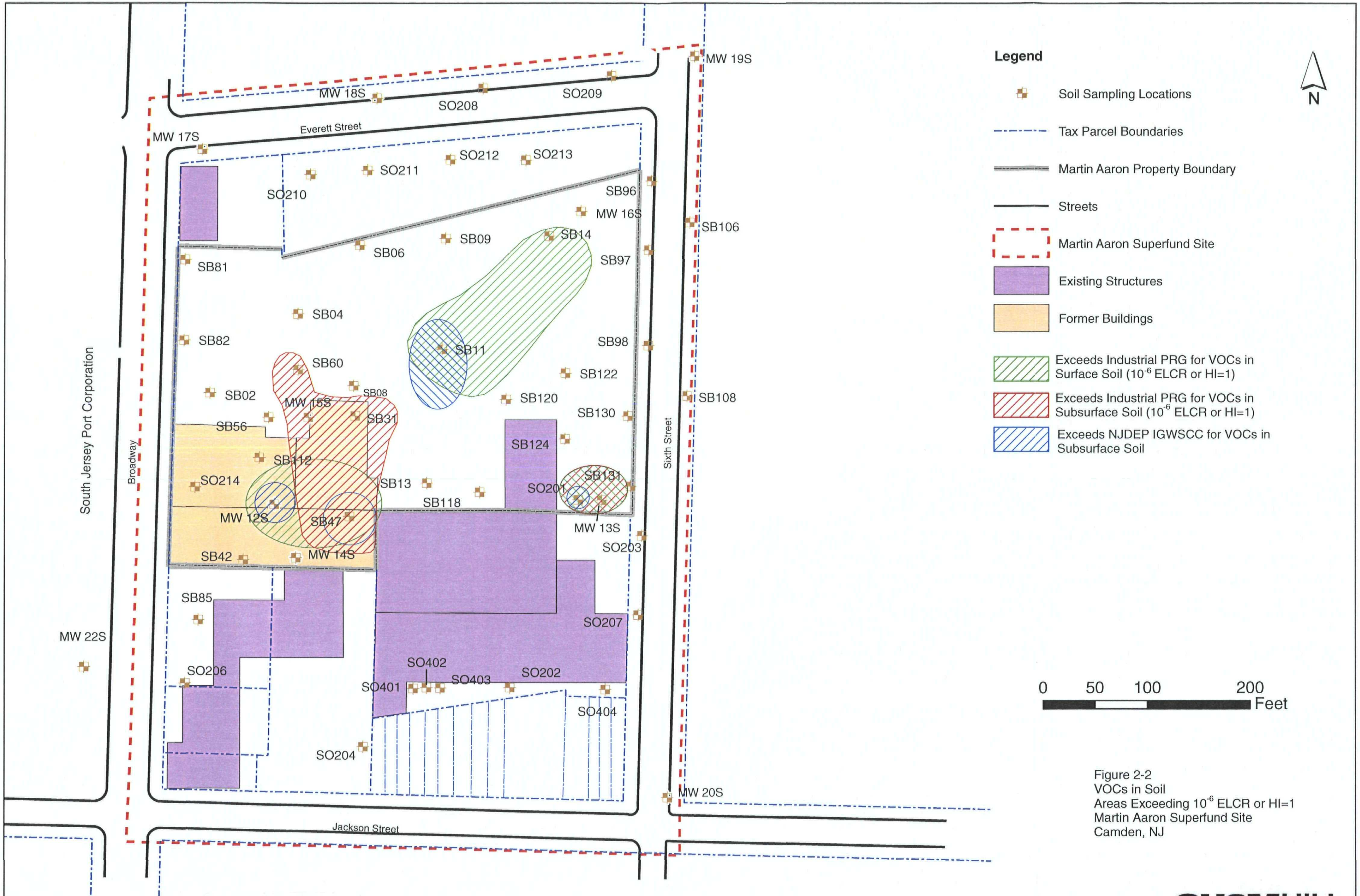


Figure 2-2
VOCs in Soil
Areas Exceeding 10^{-6} ELCR or HI=1
Martin Aaron Superfund Site
Camden, NJ

CH2MHILL

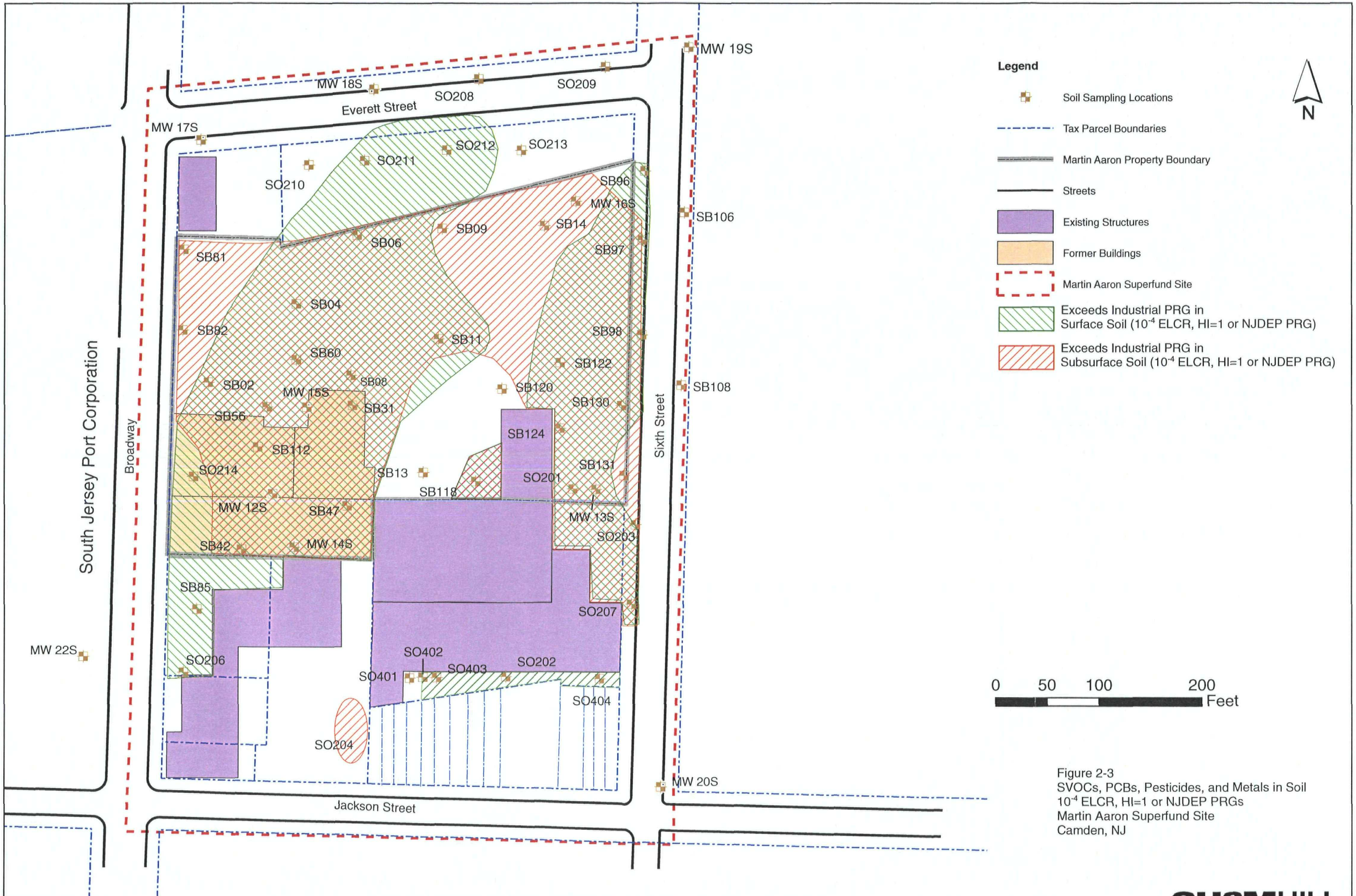


Figure 2-3
SVOCs, PCBs, Pesticides, and Metals in Soil
10^{-4} ELCR, HI=1 or NJDEP PRGs
Martin Aaron Superfund Site
Camden, NJ

CH2MHILL

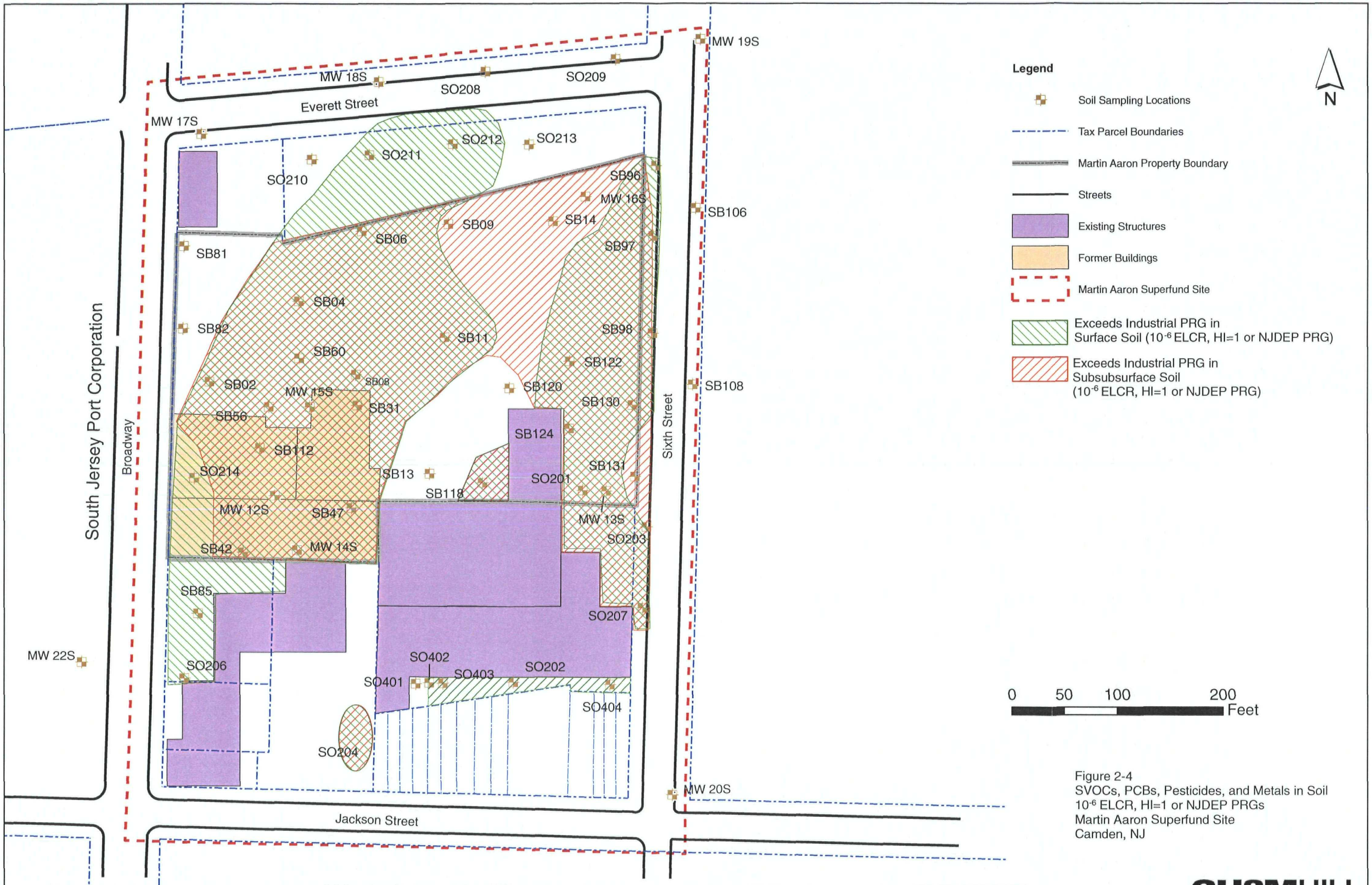


Figure 2-4
SVOCs, PCBs, Pesticides, and Metals in Soil
10^{-6} ELCR, HI=1 or NJDEP PRGs
Martin Aaron Superfund Site
Camden, NJ

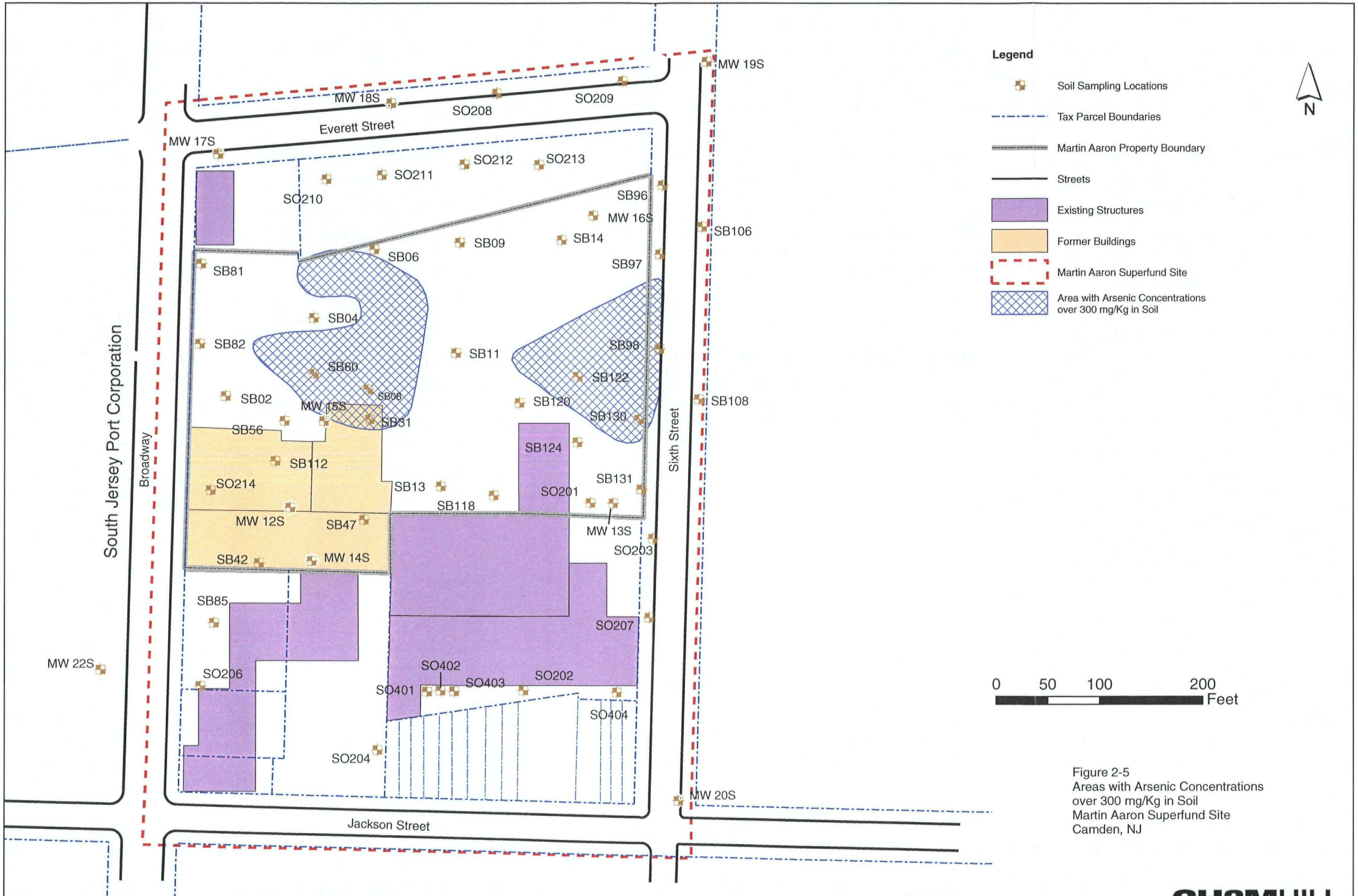


Figure 2-5
Areas with Arsenic Concentrations
over 300 mg/Kg in Soil
Martin Aaron Superfund Site
Camden, NJ

CH2MHILL

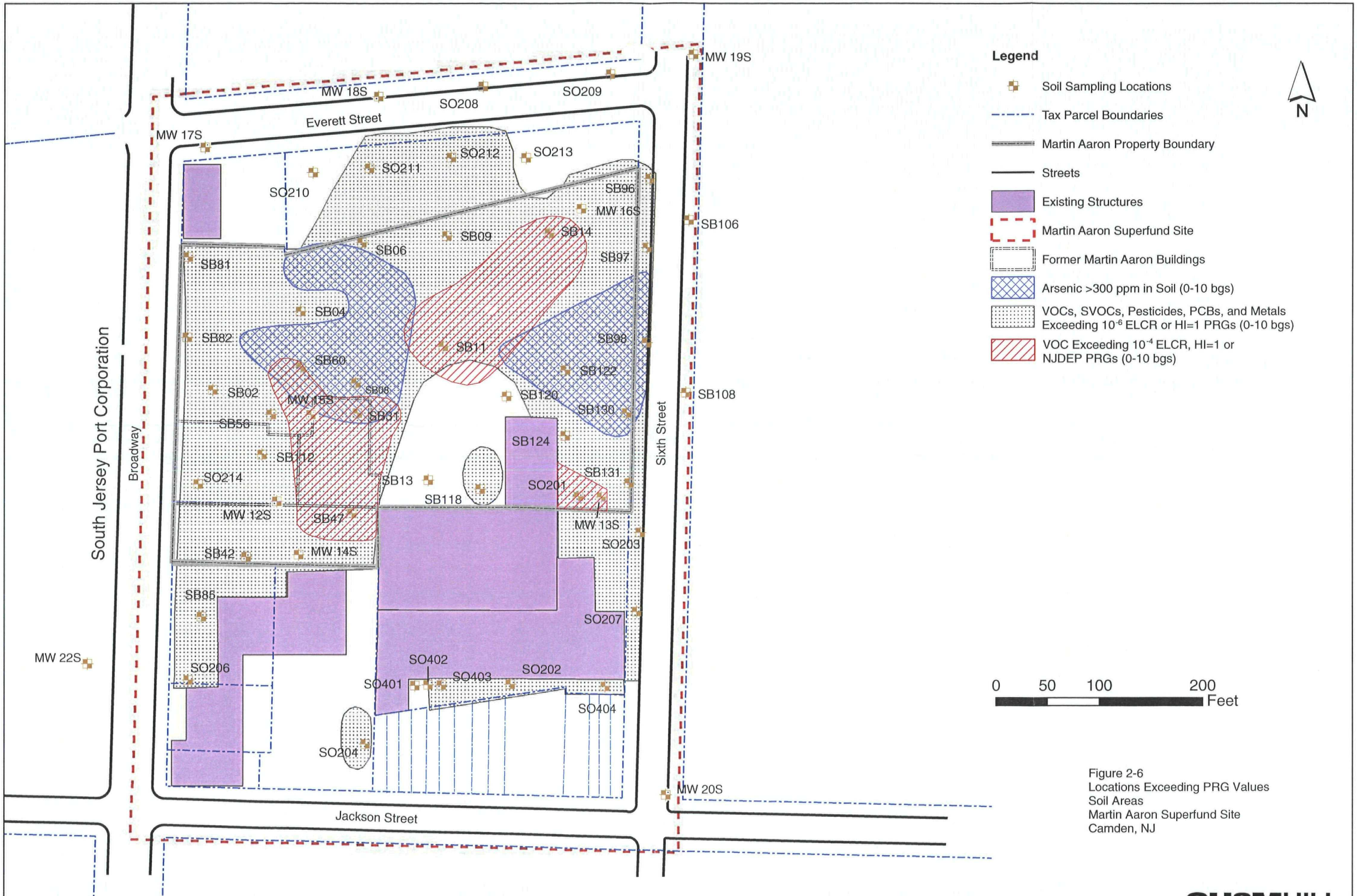


Figure 2-6
Locations Exceeding PRG Values
Soil Areas
Martin Aaron Superfund Site
Camden, NJ

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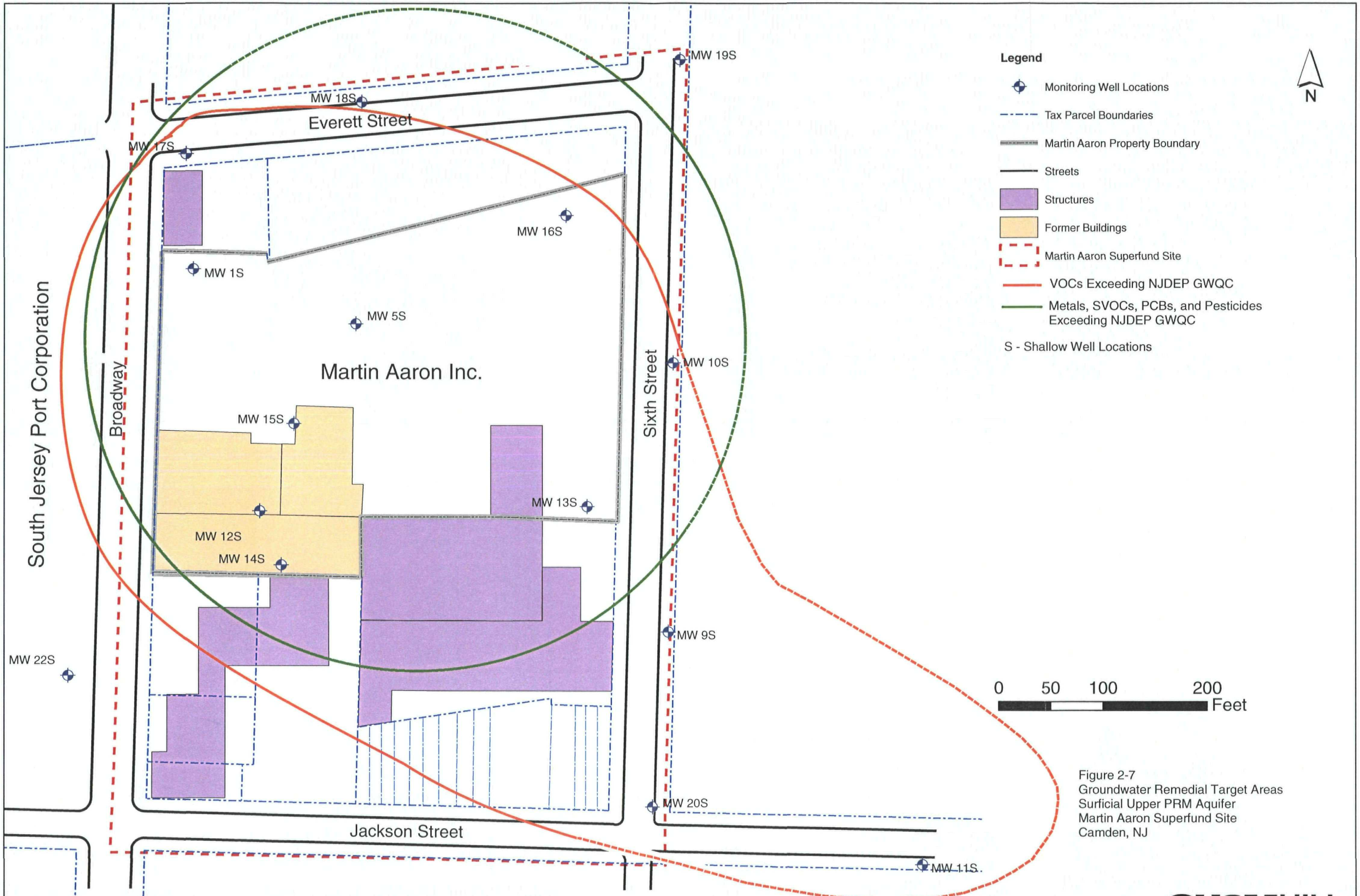

Figure 2-7
Groundwater Remedial Target Areas
Surficial Upper PRM Aquifer
Martin Aaron Superfund Site
Camden, NJ

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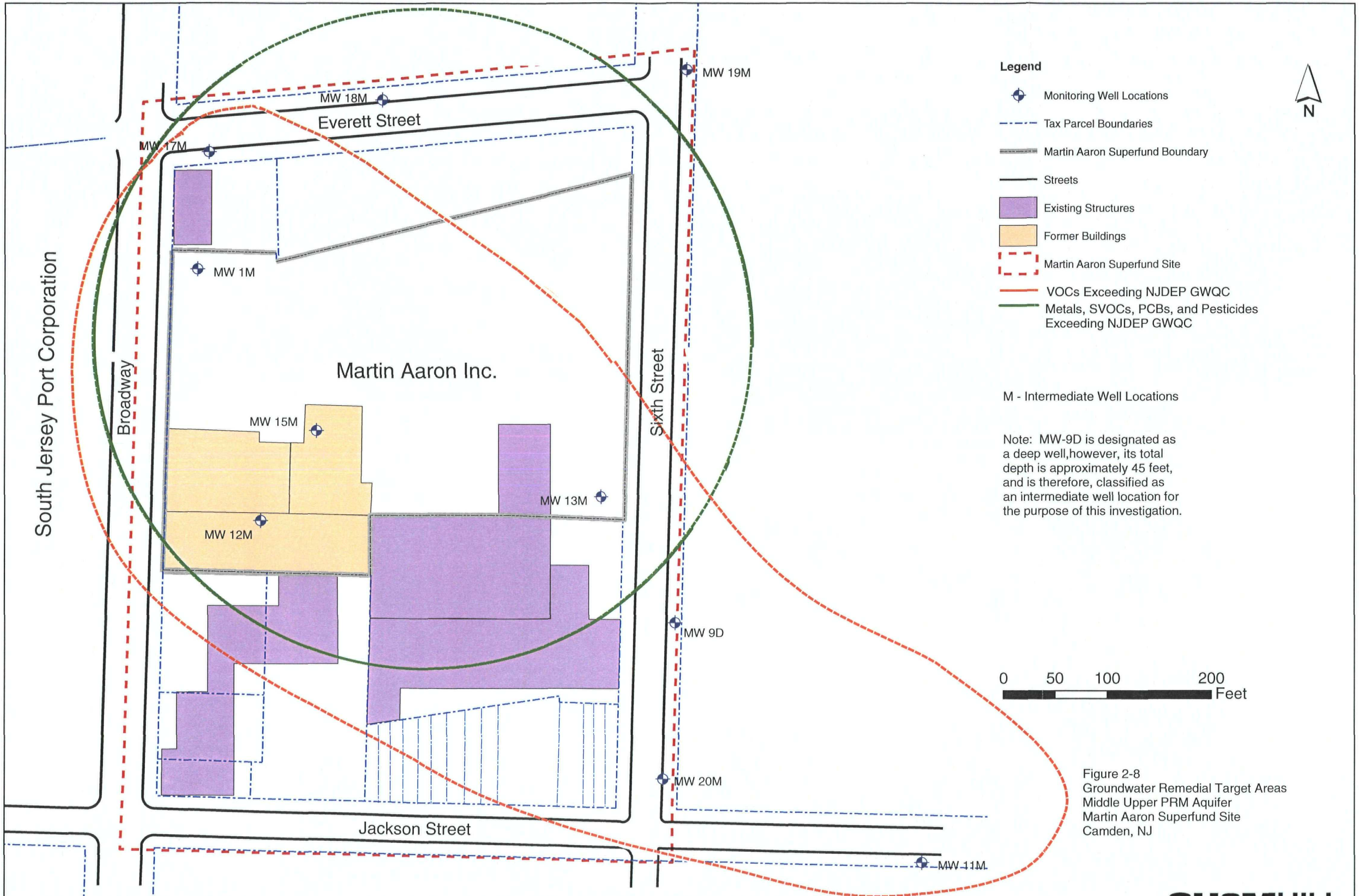

Figure 2-8
Groundwater Remedial Target Areas
Middle Upper PRM Aquifer
Martin Aaron Superfund Site
Camden, NJ

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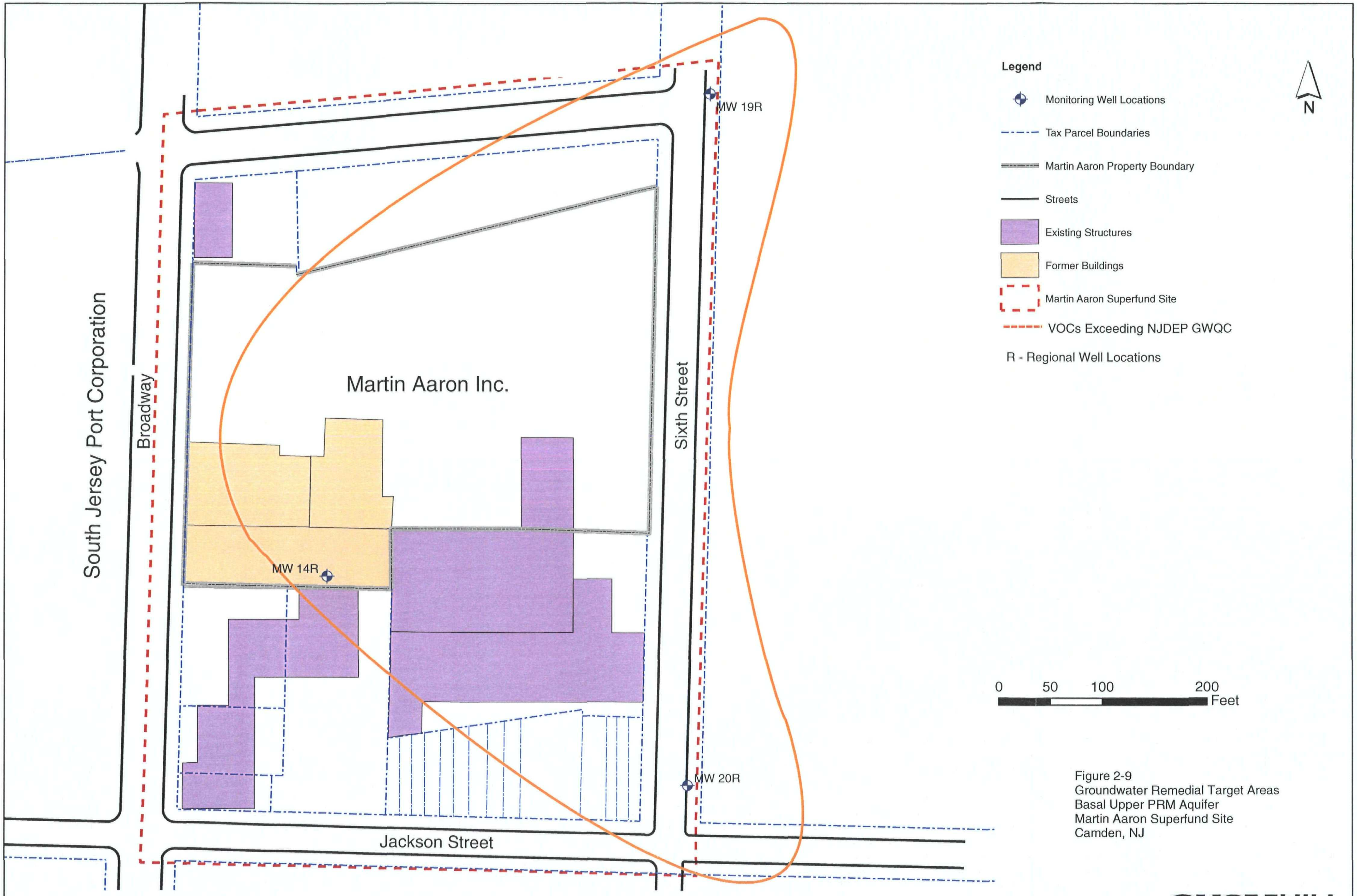

Figure 2-9
Groundwater Remedial Target Areas
Basal Upper PRM Aquifer
Martin Aaron Superfund Site
Camden, NJ

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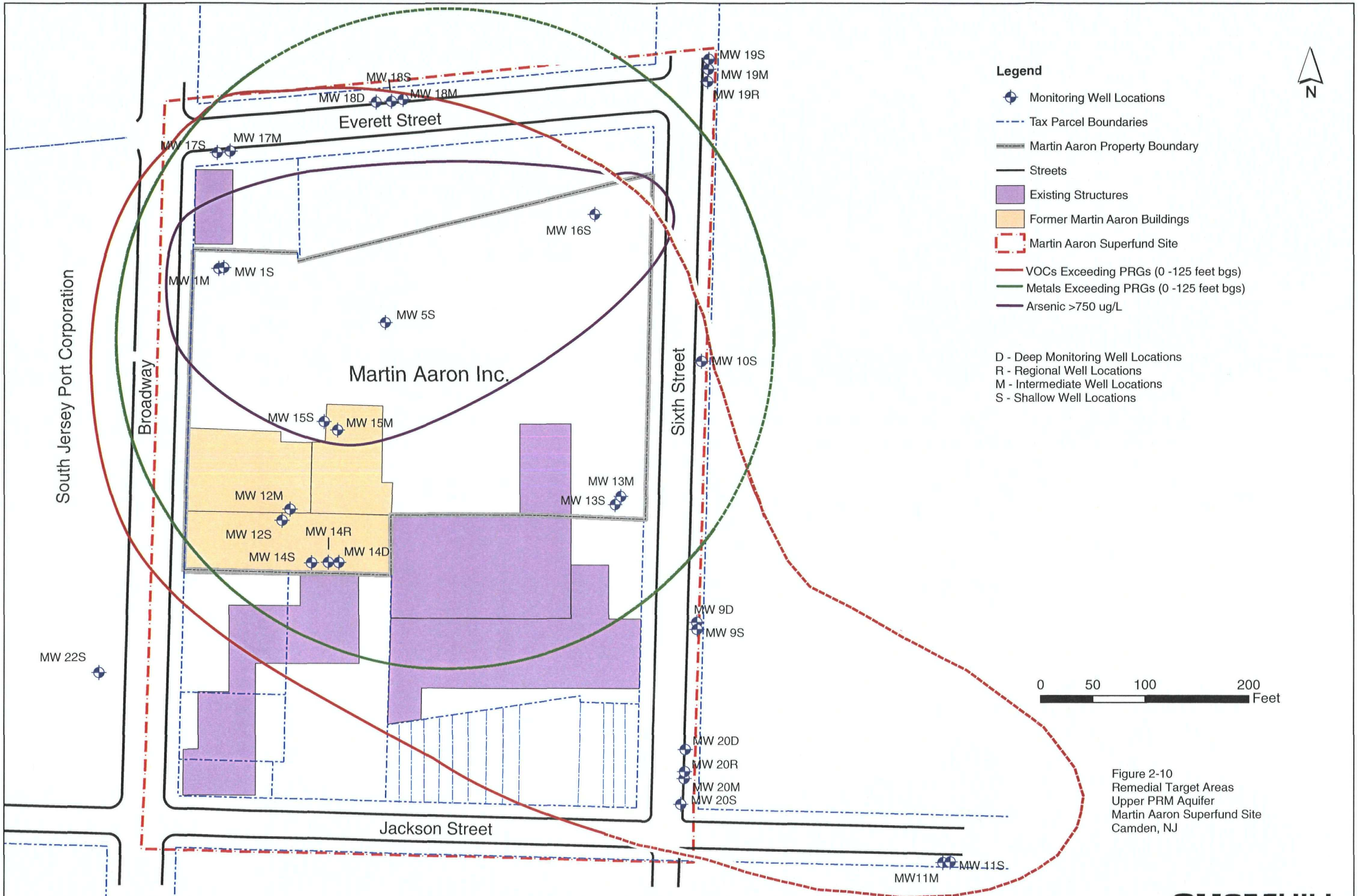

Figure 2-10
Remedial Target Areas
Upper PRM Aquifer
Martin Aaron Superfund Site
Camden, NJ

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Figure 2-11
Arsenic Isoconcentration Gradients
Surficial Upper PRM Aquifer
Martin Aaron Superfund Site
Camden, NJ

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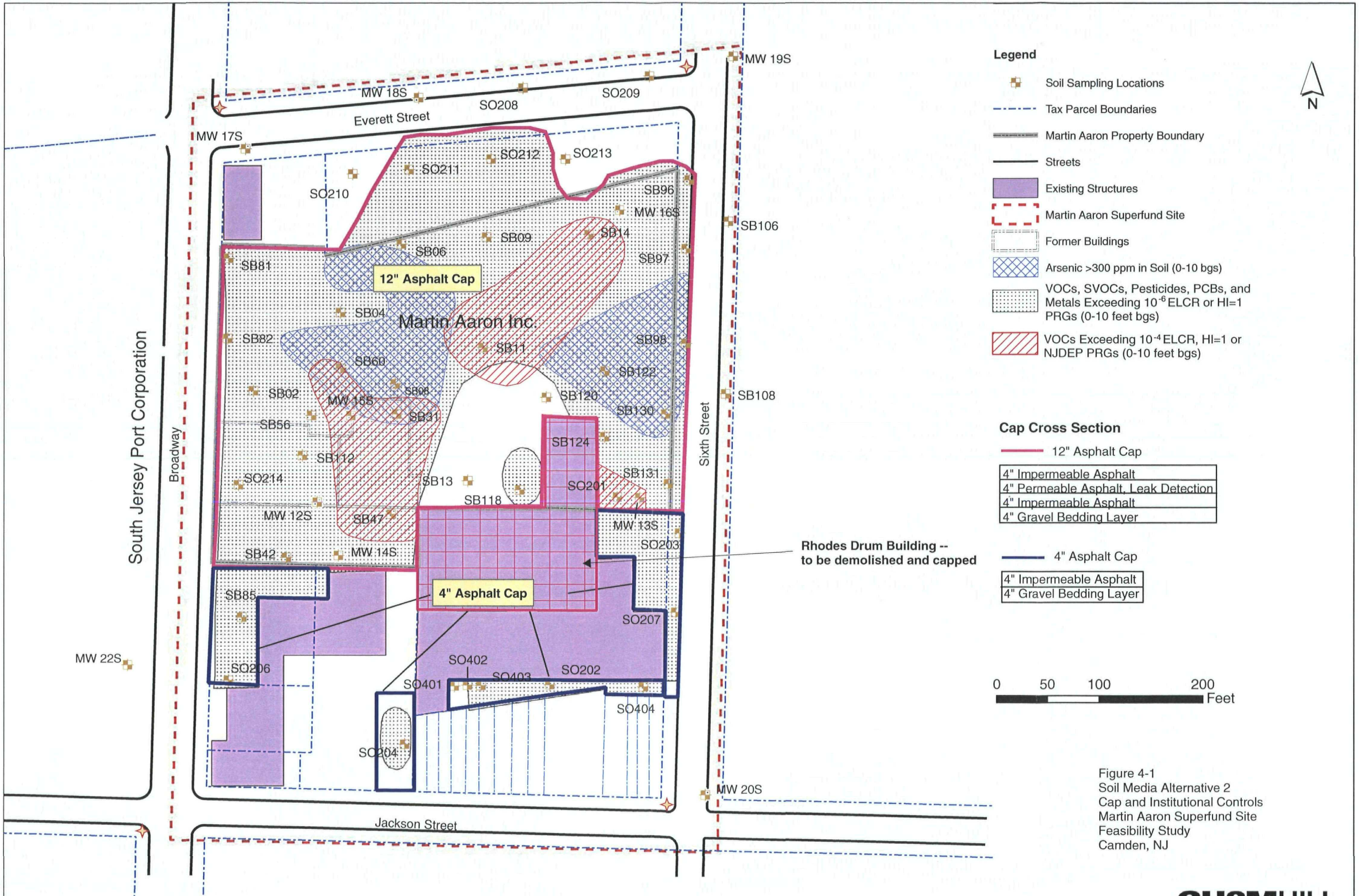
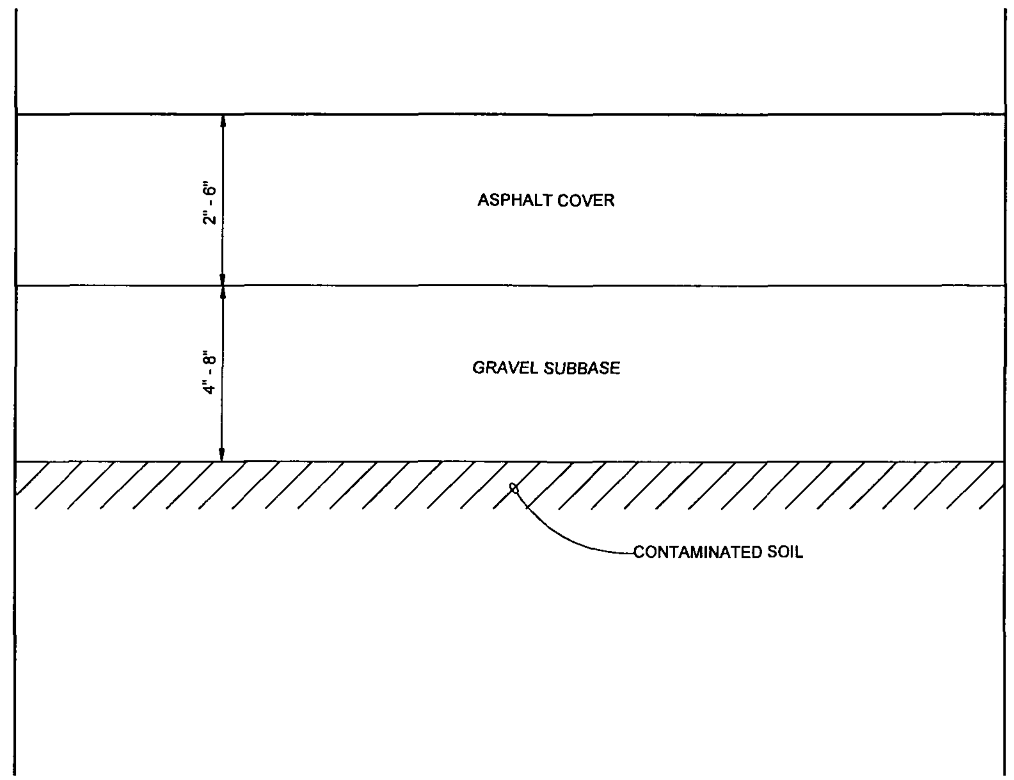
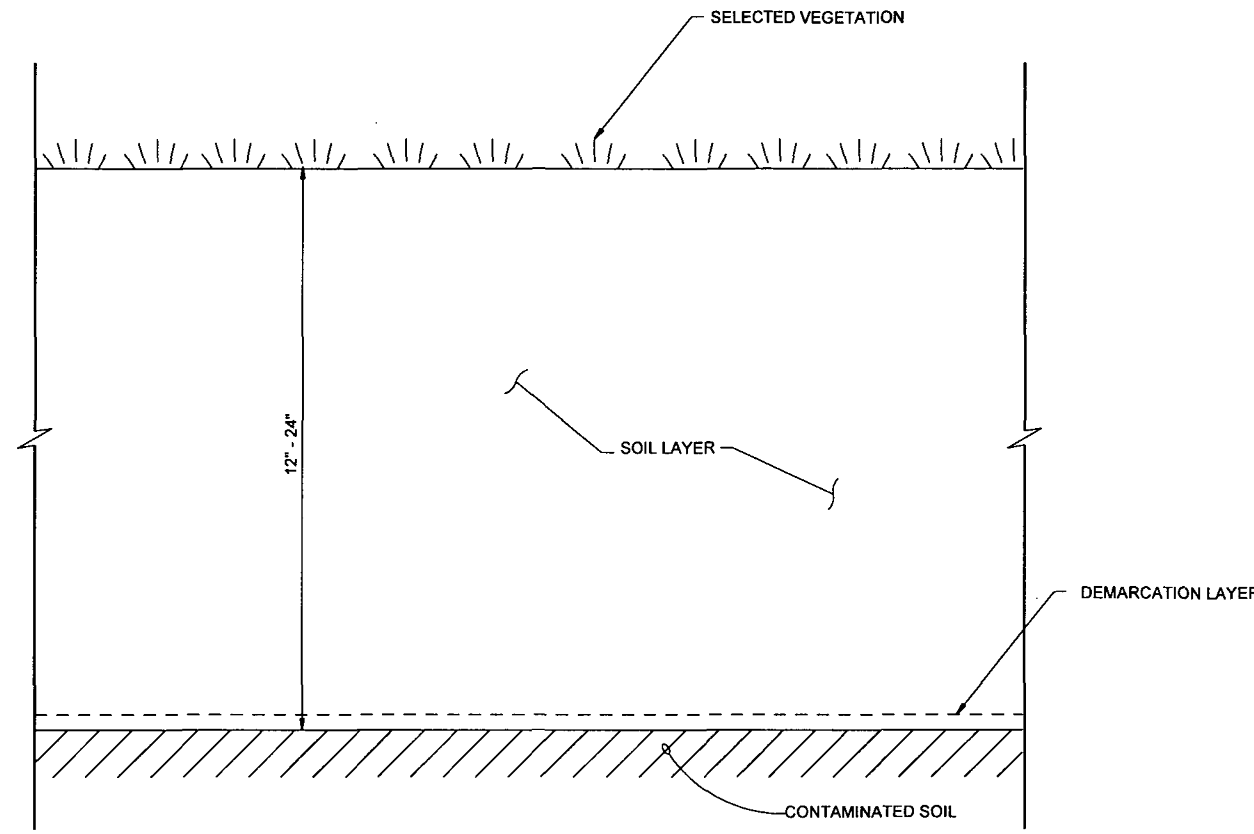


Figure 4-1
Soil Media Alternative 2
Cap and Institutional Controls
Martin Aaron Superfund Site
Feasibility Study
Camden, NJ

CH2MHILL



ASPHALT COVER
NTS



SOIL COVER
NTS

FIGURE 4-2
STANDARD SOIL AND ASPHALT COVERS
MARTIN AARON SUPERFUND SITE
CAMDEN, NEW JERSEY

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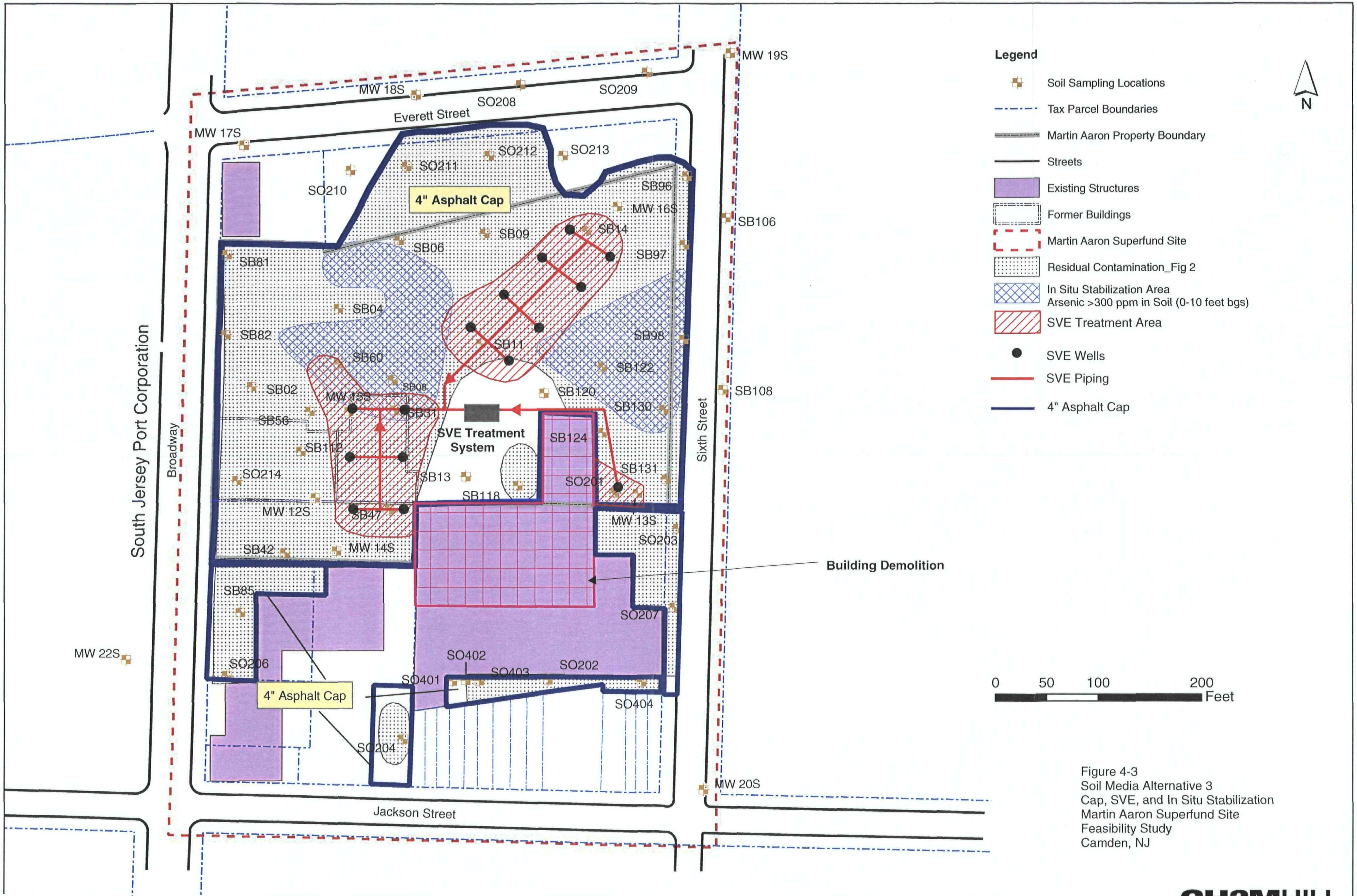

Figure 4-3
Soil Media Alternative 3
Cap, SVE, and In Situ Stabilization
Martin Aaron Superfund Site
Feasibility Study
Camden, NJ

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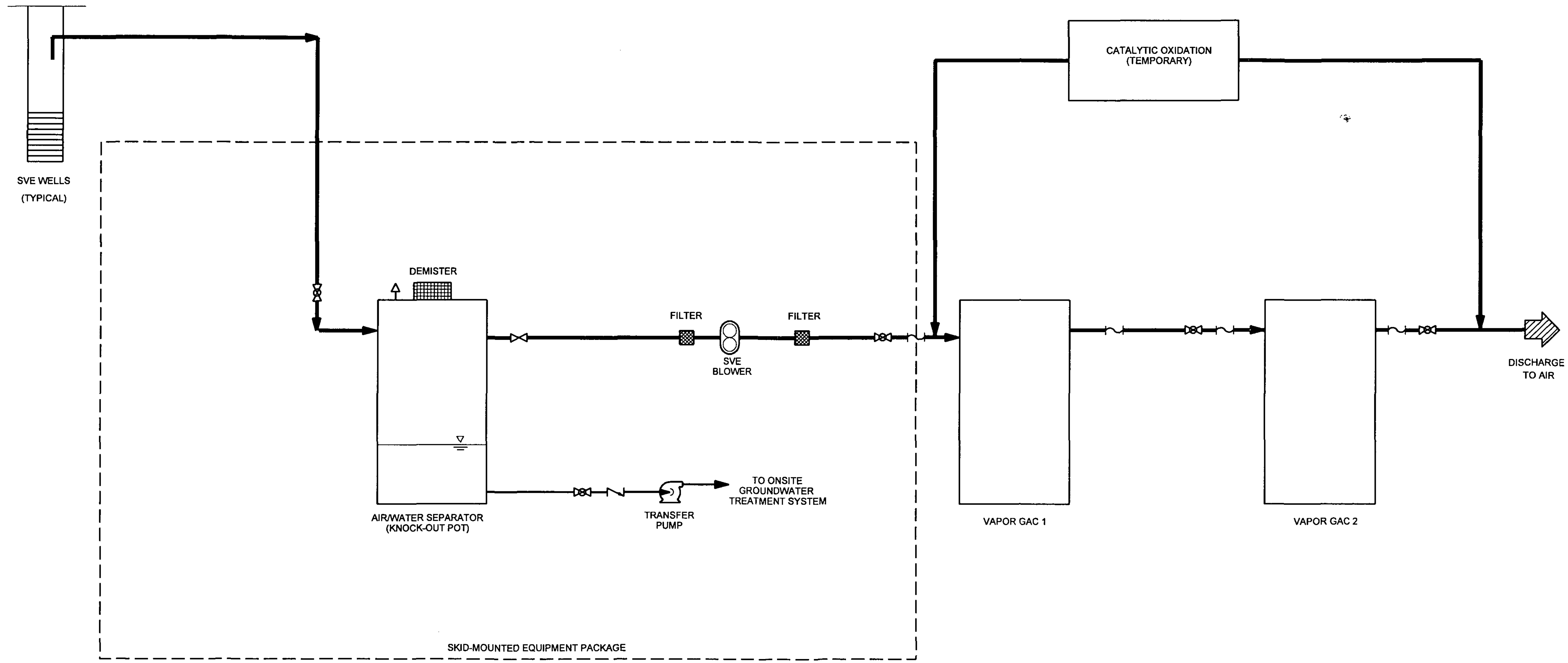

FIGURE 4-4
SOIL VAPOR EXTRACTION SYSTEM PROCESS AND INSTRUMENTATON DIAGRAM
MARTIN AARON SUPERFUND SITE
CAMDEN, NEW JERSEY

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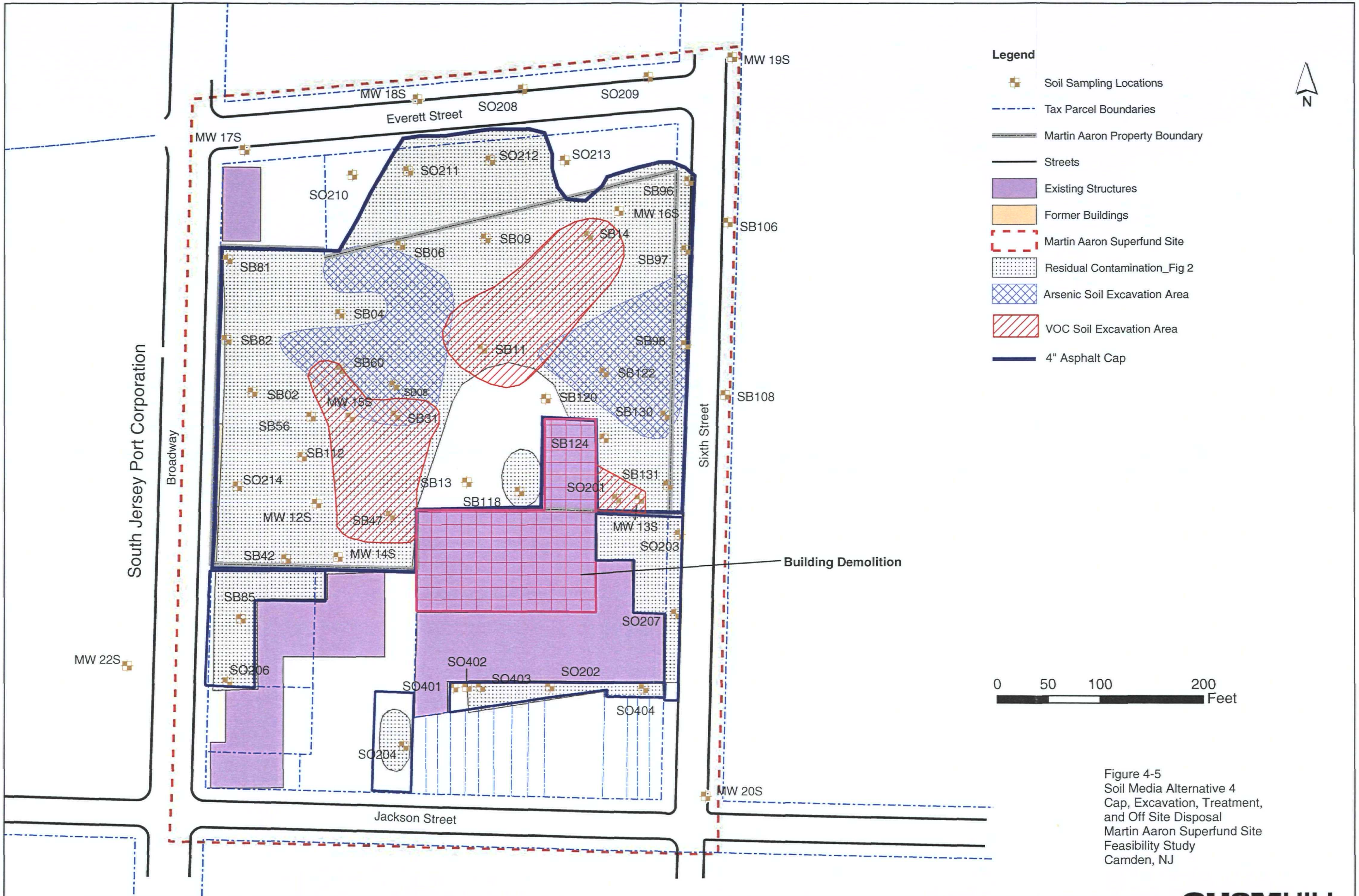

Figure 4-5
Soil Media Alternative 4
Cap, Excavation, Treatment,
and Off Site Disposal
Martin Aaron Superfund Site
Feasibility Study
Camden, NJ

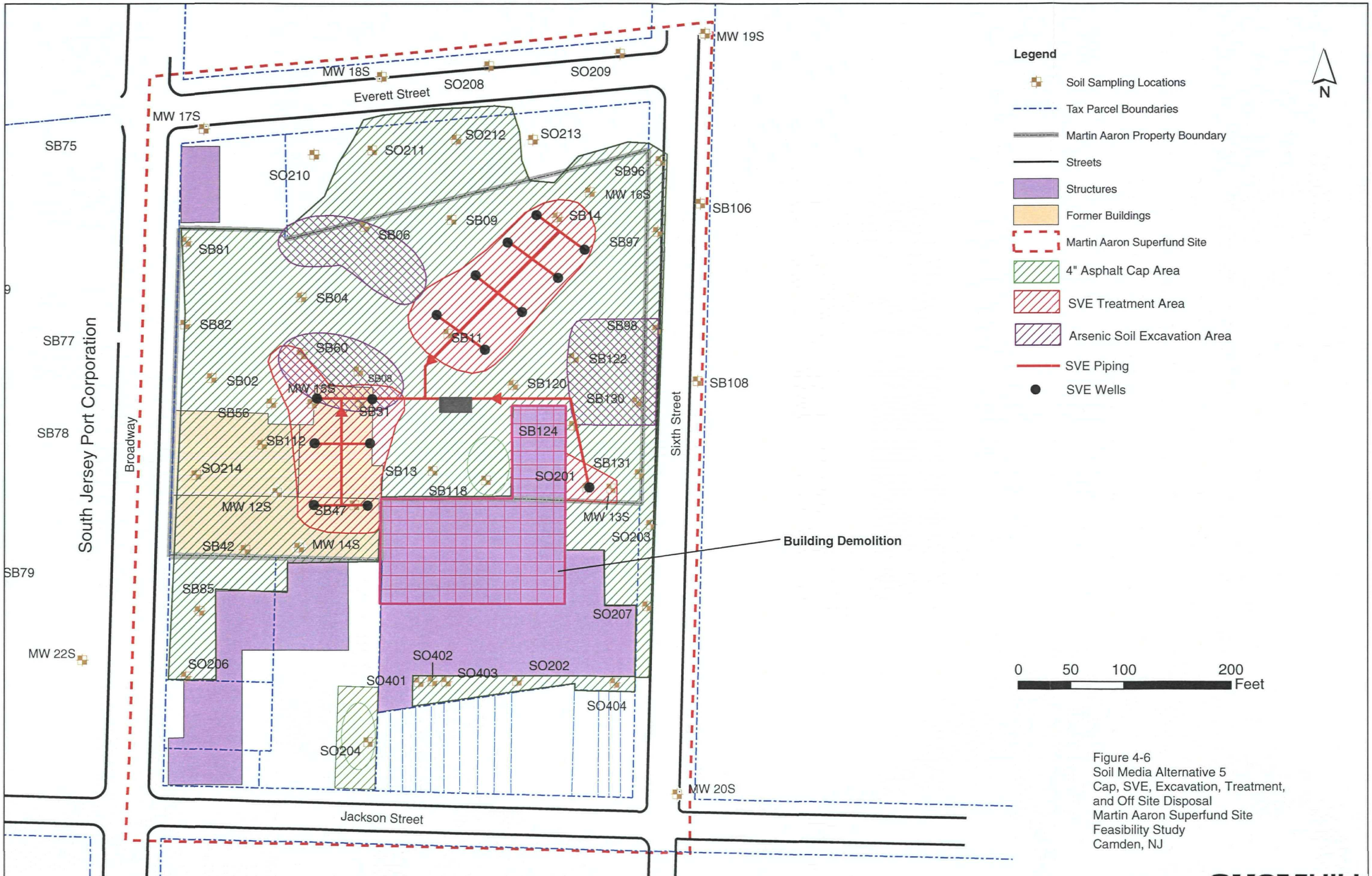

Figure 4-6
Soil Media Alternative 5
Cap, SVE, Excavation, Treatment,
and Off Site Disposal
Martin Aaron Superfund Site
Feasibility Study
Camden, NJ

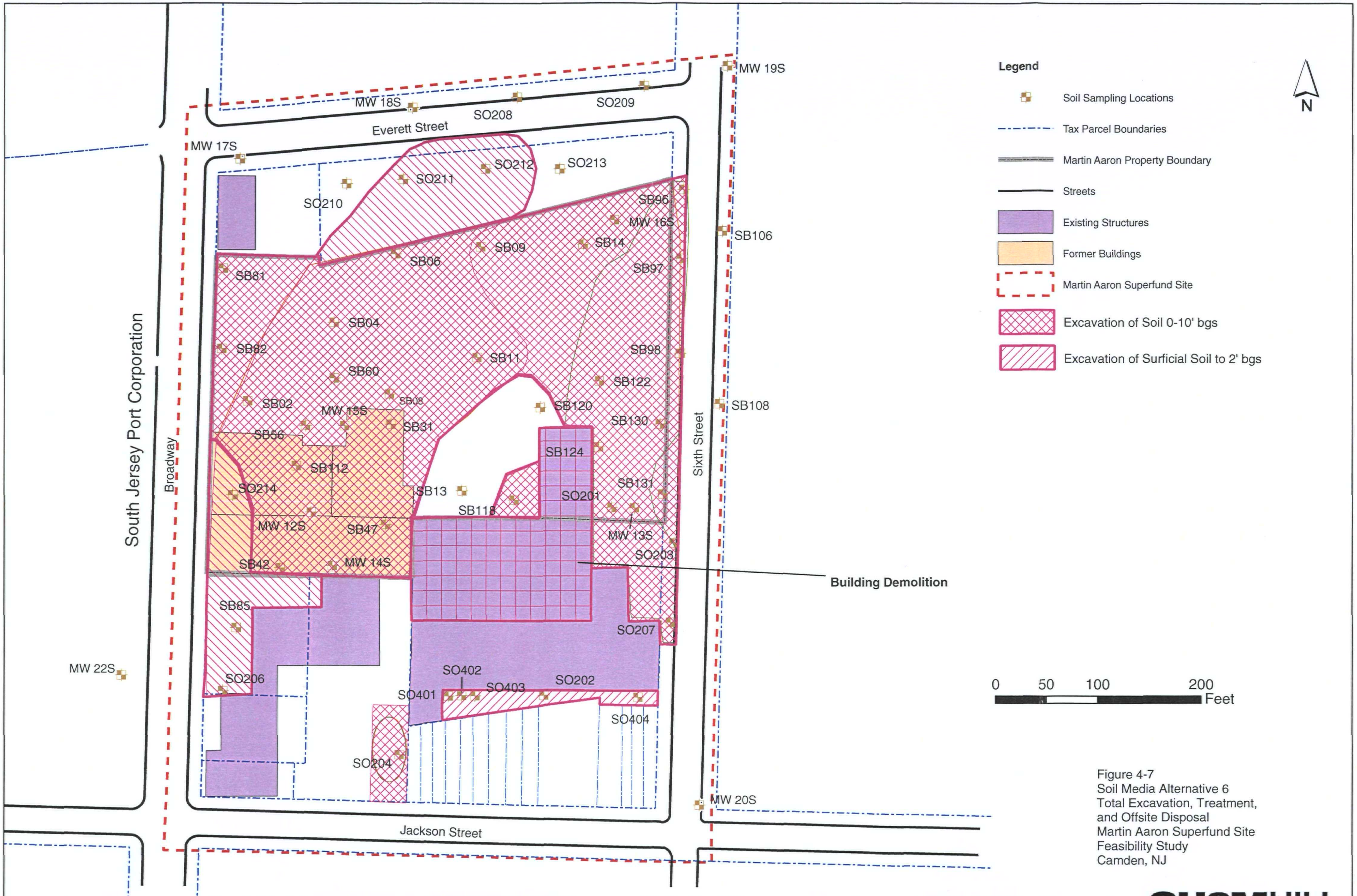

Figure 4-7
Soil Media Alternative 6
Total Excavation, Treatment, and Offsite Disposal
Martin Aaron Superfund Site
Feasibility Study
Camden, NJ

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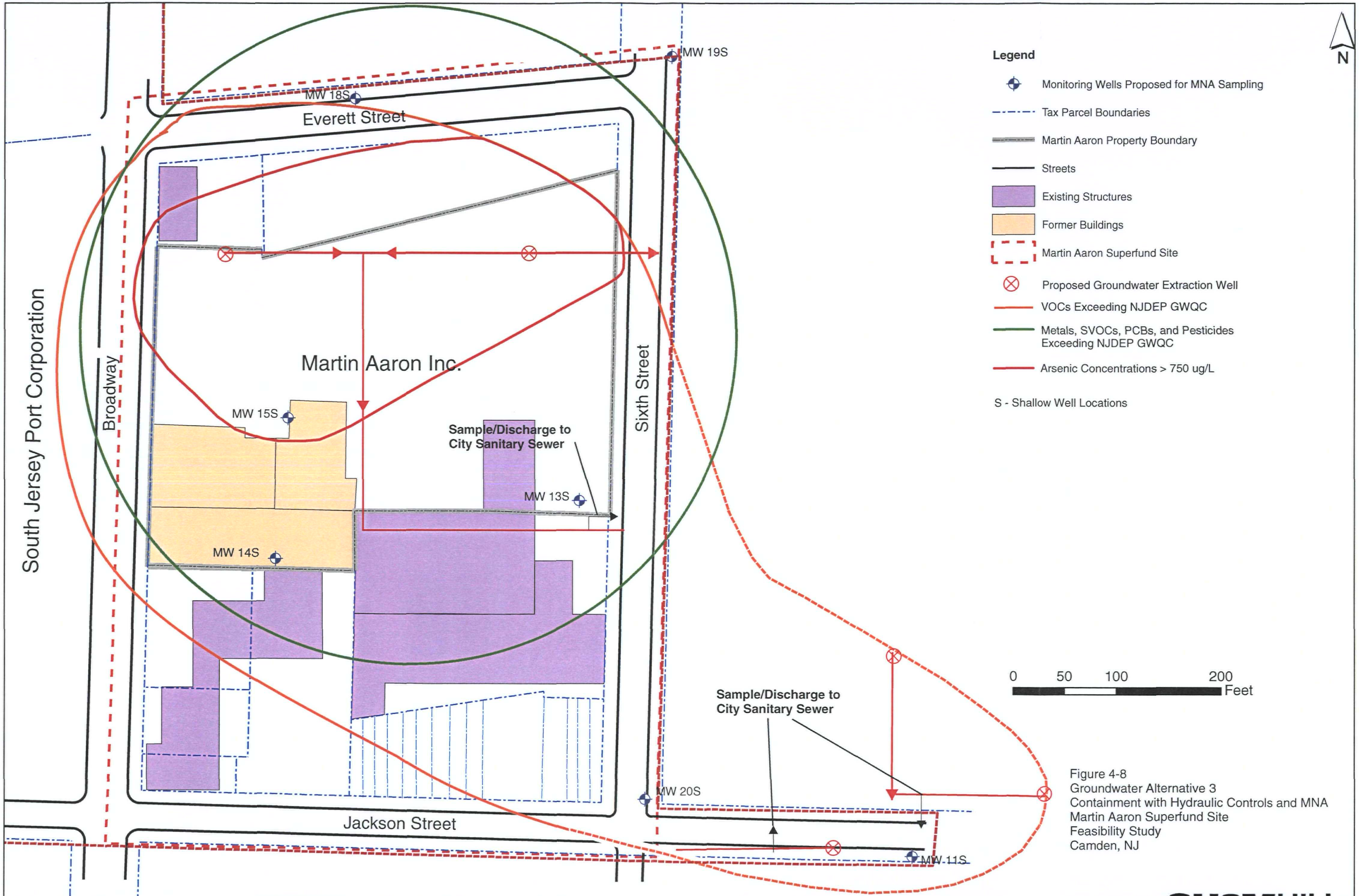

Figure 4-8
Groundwater Alternative 3
Containment with Hydraulic Controls and MNA
Martin Aaron Superfund Site
Feasibility Study
Camden, NJ

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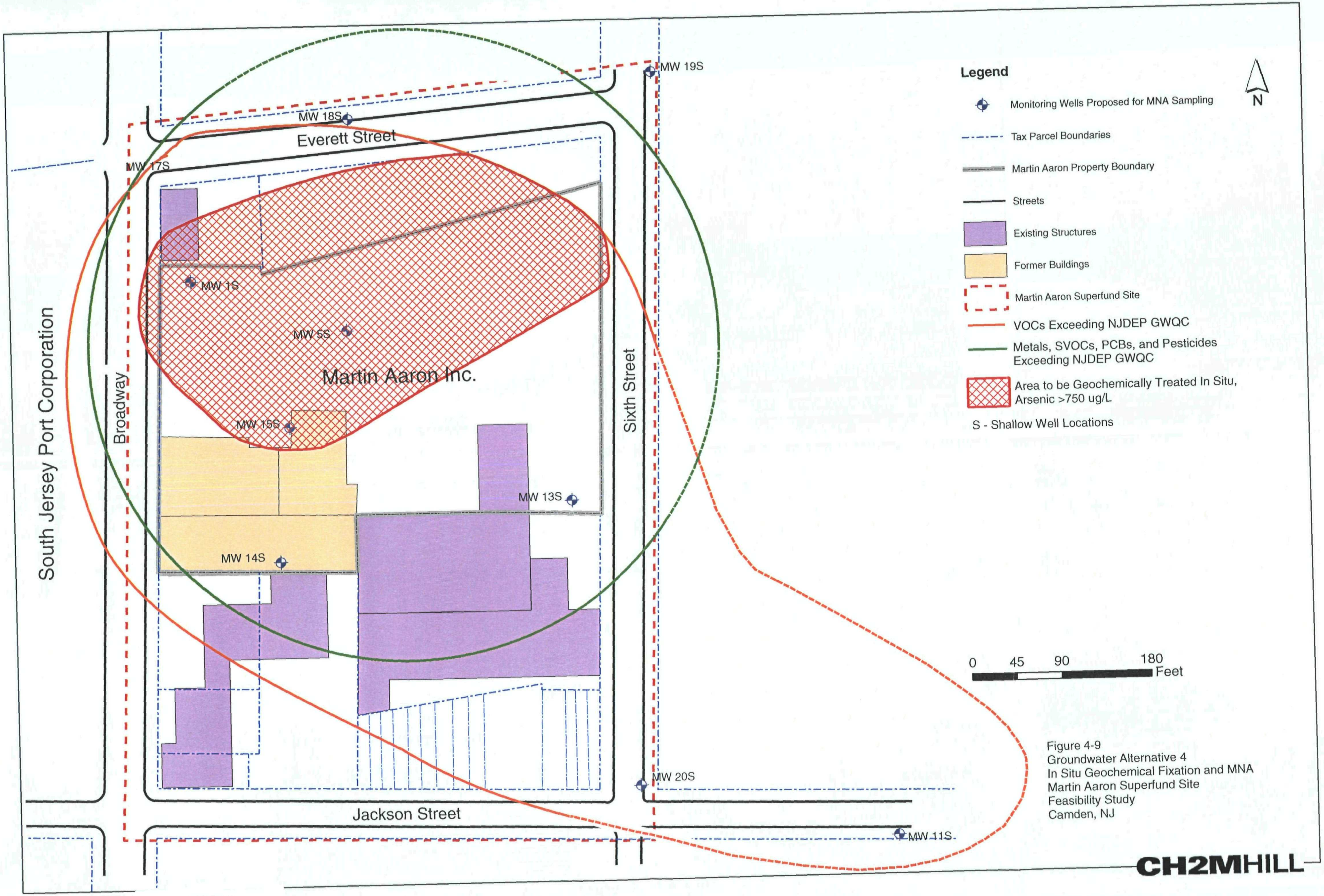

Figure 4-9
Groundwater Alternative 4
In Situ Geochemical Fixation and MNA
Martin Aaron Superfund Site
Feasibility Study
Camden, NJ

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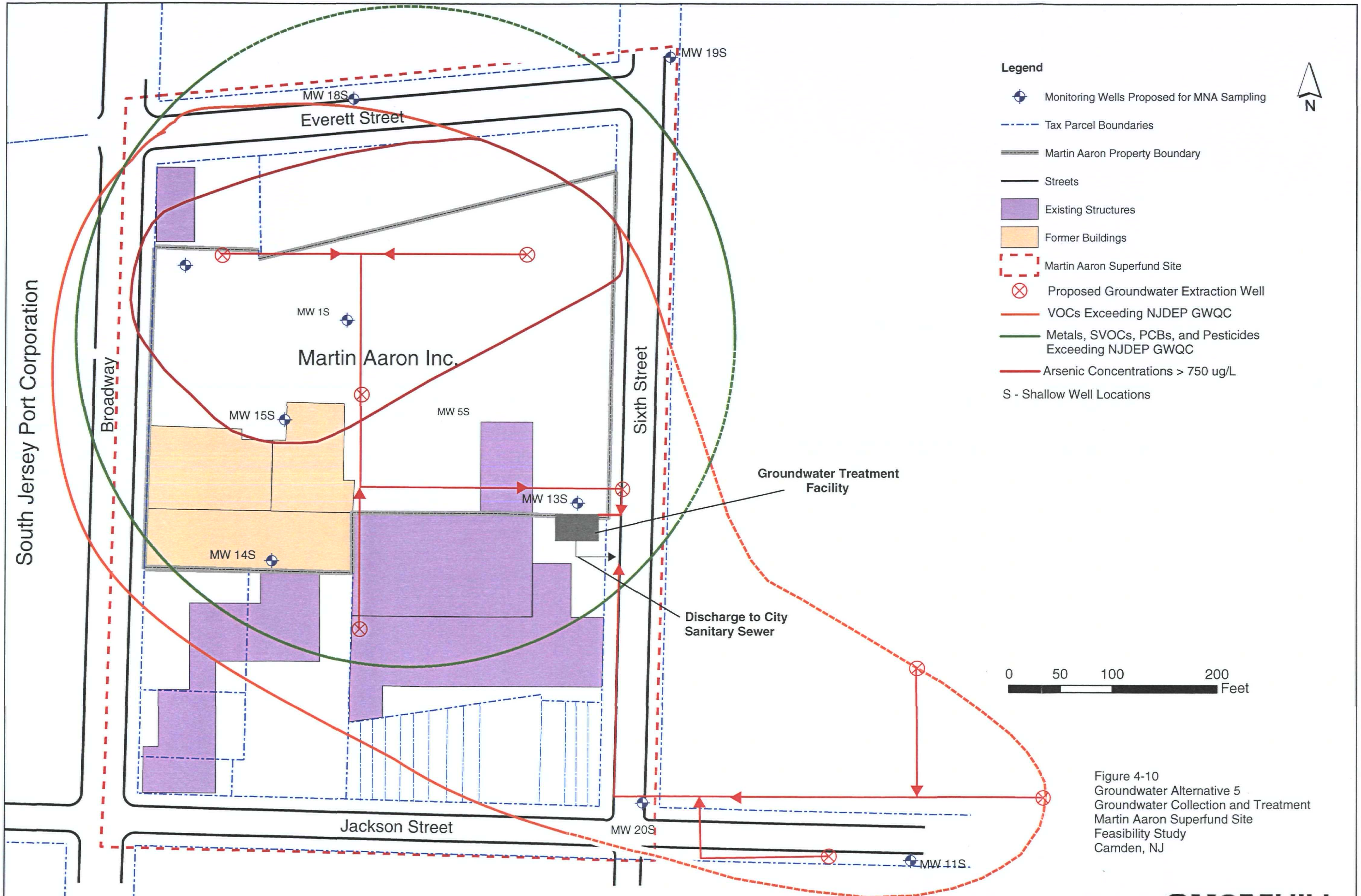

Figure 4-10
Groundwater Alternative 5
Groundwater Collection and Treatment
Martin Aaron Superfund Site
Feasibility Study
Camden, NJ

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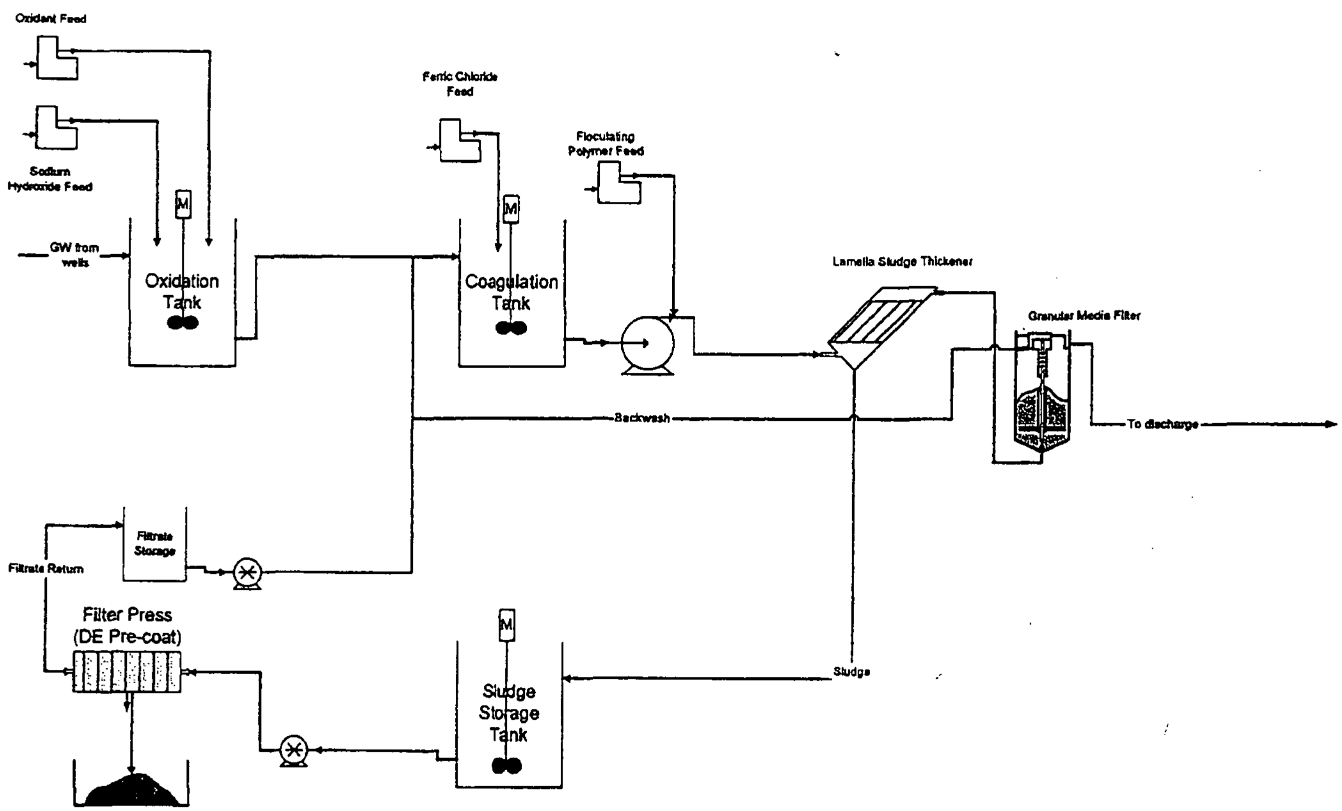

FIGURE 4-11
GROUNDWATER ALTERNATIVE 5
CHEMICAL PRECIPITATION PROCESS
MARTIN AARON SUPERFUND SITE
CAMDEN, NEW JERSEY

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Appendix A
ARARs

400116

Appendix A
Potential Chemical-Specific ARARs
Martin Aaron Superfund Site

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
Federal Safe Drinking Water Act	National Primary Drinking Water Standards - Maximum Contaminant Level Goals (MCLGs)	40 CFR 141	Establishes health-based standards for public drinking water systems. Also establishes drinking water quality goals set at levels at which no adverse health effects are anticipated, with an adequate margin of safety.	The MCLs have been applied to the remediation of groundwater.
Federal Safe Drinking Water Act	National Secondary Drinking Water Standards-Secondary MCLs	40 CFR 143	Establishes standards for public drinking water systems for those contaminants which impact the aesthetic qualities of drinking water.	
Federal Resource Conservation and Recovery Act	Groundwater Protection Standards and Maximum Concentration Limits	40 CFR 264, Subpart F	Establishes standards for groundwater protection.	
State of New Jersey Statutes and Rules	Drinking Water Standards-Maximum Contaminant Levels (MCLs)	N.J.A.C. 7:10 Safe Drinking Water Act	Establishes MCLs that are generally equal to or more stringent the SDWA MCLs.	Although there are no local receptors and all properties are served by city water, the underlying aquifer is a drinking water supply source.
State of New Jersey Statutes and Rules	National Secondary Drinking Water Standards-Secondary MCLs	N.J.A.C. 7:10-7 Safe Drinking Water Act	Establishes standards for public drinking water systems for those contaminants which impact the aesthetic qualities of drinking water.	
State of New Jersey Statutes and Rules	Groundwater Quality Standards	N.J.A.C. 7:9-6 Groundwater Quality Standards	Establishes standards for the protection of ambient groundwater quality. Used as the primary basis for setting numerical criteria for groundwater cleanups.	

Standard Requirements, Criteria, or Limitations	Citation	Description	Comments
Safe Drinking Water Act (SDWA)	40 USC 300 et seq.		
National Primary Drinking Water Standards	40 CFR 14P	Establishes health-based standards for public water systems (maximum contaminant levels [MCLs]).	MCLs are ARARs in cases where affected groundwater is or may be used directly for drinking water.
National Secondary Drinking Water Standards	40 CFR 143	Establishes welfare-based standards for public water systems (secondary maximum contaminant levels [SMCLs]).	
Maximum Contaminant Level Goals	PL 99-339, 100 Stat. 642 (1986)	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety.	
Clean Water Act (CWA)	33 USC 1251 et seq.		
Water Quality Criteria	40 CFR 131 Quality Criteria for Water, 1976, 1980, and 1986	Sets criteria for water quality based on toxicity to human health.	If water is discharged to surface water.
Ambient Water Quality Criteria	40 CFR 131	Sets criteria for ambient water quality based on toxicity to aquatic organisms.	If water is discharged to surface water.
Toxic Pollutant Effluent Standards	40 CFR 121	Establishes effluent standards or prohibitions for certain toxic pollutants; I.e., aldrin/dieldrin, DDT, DDD, DDE, endrin, toxaphene, benzideine, and PCBs	If water treatment and discharge will be required during remediation.
Resource Conservation and Recovery Act (RCRA)	42 USC 6901 et seq.		
Identification and Listing of Hazardous Wastes	40 CFR 261	Defines those solid wastes that are subject to regulation as hazardous wastes under 40 CFR 262-265, 270, and 271.	For identification of listed or characteristic RCRA wastes at a site.
Releases from Solid Waste Management Units (SWMUs)	40 CFR 264, Subpart F	Establishes maximum concentration levels for specific contaminants from a solid waste management unit (SWMU).	Probably not ARARs for state Superfund sites.
Land Disposal Restrictions (LDRs)	40 CFR 268	Establishes treatment standards for land disposal of hazardous wastes.	Applicable materials will be disposed of on land.

Standard Requirements, Criteria, or Limitations	Citation	Description	Comments
Clear Air Act (CAA)	42 USC 7401		
National Ambient Air Quality Standards	40 CFR 50	Establishes primary and secondary standards for six pollutants to protect the public health and welfare.	These are ARARs for remedial alternatives that would result in emissions of the specific pollutants during implementation.
National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR 61	Establishes regulations for specific air pollutants such as asbestos, beryllium, mercury, vinyl chloride, and benzene.	Potentially not applicable to contaminants at this site.
New Performance Standards for Criteria and Designated Pollutants	40 CFR 60	Establishes new source performance standards (NSPSs) for certain classes of new stationary sources.	Potentially not applicable because the remediation will not involve a new source (e.g., an on-site incinerator) subject to NSPS.
New Jersey Statutes and Rules	New Jersey Administrative Code (N.J.A.C.); New Jersey Statutes Annotated (N.J.S.A)		
Drinking Water Standards - maximum contaminant levels (MCLs)	58 N.J.S.A. 12A-1	Establishes MCLs that are generally equal to or more stringent than SDWA MCLs.	Although there are no local receptors and all properties are served by city water, the underlying aquifer is a drinking water supply source.
Technical requirements for site remediation, and guidance document for the remediation of contaminated soils	N.J.A.C. 7:26E	Establishes minimum regulatory requirements for remediation of contaminated sites in New Jersey.	While a federal EPA lead, these requirements have been identified as applicable to the site.
National Historic Preservation Act	16 USC 469 et seq. 40 CFR 6301(c)	Establishes procedures to provide for preservation of historical and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	If historical or archaeological data could potentially be encountered during remediation.
Fish and Wildlife Coordination Act	16 USC 661-666	Requires consultation when federal department or agency proposes or authorizes any modification of any stream or other water body and adequate provision for protection of fish and wildlife resources.	Not an ARAR because the response actions will not affect surface water bodies.
Clean Water Act (CWA)	33 USC 1251-1376		
Dredge of Fill Requirements (Section 404)	40 CFR 230-231	Requires discharges to address impacts of discharge of dredge or fill material on the aquatic ecosystem.	Not an ARAR because the response actions will not involve discharge of dredge or fill into surface water body.

Standard Requirements, Criteria, or Limitations	Citation	Description	Comments
Executive Order on Flood Plain Management	Executive Order 11988	Requires federal agencies to evaluate the potential effects of actions they may take in a flood plain to avoid, to the extent possible, the adverse impacts associated with direct and indirect development of a flood plain.	An ARAR if any portion of the site us within the 100-year flood plain..
New Jersey Flood Hazard Control Act	N.J.A.C. 7:13	State standards for activities within flood plains.	An ARAR for those aspects of the site work that are within the flood plain.
New Jersey Freshwater Protection Act	N.J.S.A. 13:9B-1; N.J.A.C 7:7A	Require permits for regulated activity disturbing wetlands.	Not an ARAR because no wetlands on site would be affected.
Endangered Species Act	16 USC 1531 et seq.; 40 CFR 400	Standards for the protection of threatened and endangered species.	Not an ARAR because no listed species identified at the site.
Endangered and Non-Game Species Act	N.J.S.A. 23:2A-1	Standards for the protection of threatened and endangered species.	Not an ARAR because no listed species identified at the site.
Fish and Wildlife Coordination Act	16 USC 661 et seq.	Requires conservation of fish and wildlife and their habitats.	Not and ARAR because this site does not contain fish and wildlife habitat.
New Jersey Uniform Construction Code	N.J.A.C. 5:23	Establishes standards for all new construction and renovation.	This may be an ARAR to the extent that new construction falls within the standards.
Clean Water Act (CWA)	33 USC 1251-1376		
National Pollutant Discharge Elimination System (NPDES)	40 CFR 125	Requires permit for the discharge of pollutants for any point source and stormwater runoff for specific Standard Industrial Codes (SICs) into waters of the United States.	Substantive requirements for a permit will be required for discharge to a surface water body if water generated during the remediation is discharged to surface water.
Effluent Guidelines and Standards for the Point Source Category	40 CFR 414	Requires specific effluent characteristics for discharge under NPDES permits.	Probably not applicable because there will be no ongoing commercial activity at a state Superfund site.
National Pretreatment Standards	40 CFR 403	Sets standards to control pollutants that pass through or interfere with treatment processes in public treatment works or that may contaminate sewage discharge.	Only if the selected alternative includes discharge of water to a POTW.
Resource Conservation and Recovery Act (RCRA)	42 USC 6901-6987		
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR 257	Establishes criteria for use in determining which solids waster disposal facilities and practices pose a reasonable probability of adverse effects on public health or the environment and thereby constitute prohibited open dumps.	Not an ARAR because on-site disposal is not an option at the site.

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Standard Requirements, Criteria, or Limitations	Citation	Description	Comments
Standards Applicable to Generators of Hazardous Wastes	40 CFR 262	Establishes standards for generators of hazardous wastes.	An ARAR because response action involves soil or water that would be considered hazardous under RCRA.
Standards Applicable to Transporters of Hazardous Wastes	40 CFR 263	Establishes standards that apply to transporters of hazardous wastes within the United States if the transportation requires a manifest under 40 CFR 262.	An ARAR because action involves off-site transportation of soil or water that would be considered hazardous under RCRA.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDFs)	40 CFR 264	Establishes minimum national standards that define the acceptable management of hazardous wastes for owners and operators of facilities that treat, store, or dispose of hazardous wastes.	Part 264 requirements may be ARARs for certain remedial actions under CERCLA. See each subpart that follows.
General Facility Standards	Subpart B	Establishes minimum standards for treatment, storage, and disposal facilities (TSDFs).	May be an ARAR if any remedial actions are selected for which other subparts of 264 are relevant and appropriate.
Preparedness and Prevention	Subpart C	Establishes minimum standards for hazard management.	Not an ARAR because on-site storage or treatment will not be conducted.
Contingency Plan and Emergency Procedures	Subpart D	Establishes minimum standards for hazard management.	Not an ARAR because on-site storage or treatment will not be conducted.
Manifest System, Recordkeeping, and Reporting	Subpart F	Establishes standards for tracking waste during off-site transport.	An ARAR because response action will involve off-site transport of hazardous waste.
Releases from Solid Waste Management Units (SWMUs)	Subpart F	Establishes standards for control of SWMUs.	Not an ARAR because response action will not involve on-site disposal.
Closure and Post-Closure	Subpart G	Establishes standards for site closure.	CERCLA establishes review of remedial actions should contaminants be left on-site. Substantive requirements need to be met, including monitoring and deed notices.
Financial Requirements	Subpart H	Establishes administrative requirements for demonstrating fiscal responsibilities.	These are administrative requirements only.
Use and Management of Containers	Subpart I	Establishes standards for container storage.	May be ARARs if an alternative would involve storage of containers of hazardous wastes.

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Standard Requirements, Criteria, or Limitations	Citation	Description	Comments
Tanks	Subpart J	Establish standards for tank storage and handling.	May be ARARs if an alternative would involve use of tanks to treat or store hazardous materials.
Surface Impoundments	Subpart K	Establishes standards for surface-impounded wastes.	Not an ARAR because alternatives would not involve a surface impoundment to treat, store, or dispose of hazardous materials.
Waste Piles	Subpart L	Established standards for managing wastes in piles.	Not an ARAR because alternatives would not treat or store hazardous materials in piles.
Land Treatment	Subpart M	Establishes standards for managing land treatment.	Not an ARAR because alternatives would not involve on-site treatment.
Landfills	Subpart N	Establishes standards for managing landfills.	May be ARAR if an alternative would involve disposal of hazardous materials in a landfill.
Incinerators	Subpart O	Establishes standards for incineration of wastes.	May be ARARs if an incinerator alternative is selected.
Interim Standard for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR 265	Establishes minimum national standards that define the acceptable management of hazardous wastes during the period of interim status and until certification of final closure or if the facility is subject to post-closure requirements, until post-closure responsibilities are fulfilled.	Remedies should be consistent with the more stringent Part 264 standards, as these represent the ultimate RCRA compliance standards and are consistent with CERCLA's goal of long-term protection of public health and welfare and the environment.
Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities	40 CFR 266	Establishes requirements that apply to recyclable materials that are reclaimed to recover economically significant amounts of precious metals.	Does not establish additional cleanup requirements.
Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities	40 CFR 267	Establishes minimum standards that define acceptable management of hazardous wastes for new land disposal facilities.	Remedies should be consistent with the more stringent Part 264 standards, as these represent the ultimate RCRA compliance standards and are consistent with CERCLA's goal of long-term protection of public health and the environment.
Land Disposal Restrictions	40 CFR 268	Identifies hazardous wastes that are restricted from land disposal and describes those circumstances under which an otherwise prohibited waste may be disposed of on land.	An ARAR because alternatives include land application of wastes.

Standard Requirements, Criteria, or Limitations	Citation	Description	Comments
Hazardous Waste Permit Program	40 CFR 270	Establishes provisions covering basic EPA permitting requirements.	A permit is not required for on-site CERCLA response actions. Substantive requirements are addressed in 40 CFR 264.
Underground Storage Tanks	40 CFR 280	Establishes regulations related to underground storage tanks (USTs).	No alternative involving the use of USTs is anticipated.
Resource Conservation and Recovery Act (RCRA) Rule Change	57 FR 37193	Addresses the LDRs for hazardous debris.	An RAR because debris is present.
Corrective Action Management Units (CAMUs) and Temporary Units (Tus)	40 CFR, Subpart S, Part 264	Enables availability of CAMUs to those who initiate corrective action and seek agency approval under RCRA.	Not an ARAR.
RCRA LDRs, Phase II	57 FR 27880, 30657, 37284, 47376, and 6149	Establishes a list of items considered industrial waste as a solid or hazardous waste.	Not applicable because there will be no ongoing commercial activity.
RCRA LDRs, Phase II	57 FR 12	EPA clarification that a waste is not presumptively hazardous merely because it contains as Appendix VIII hazardous waste constituent.	Applicable is ongoing commercial activity occurs.
RCRA LDRs, Phase II	57 FR 21524 as corrected by 57 FR 29220	Establishes management standards for recycled oils.	Not applicable because recycled oils are not present.
RCRA	40 CFR 265	Establishes organic air emission standards for tanks, surface impoundments, and containers.	Applicable to hazardous waste treatment, storage, and disposal facilities (TSDFs) that receive new or re-issued permits or Class 3 modifications after 5 January 1995.
RCRA LDRs, Phase II	EPA, 976 F.2d 2, 17-18 (D.C. Cir 1992)	Establishes universal treatment standards and treatment standards for organic toxicity characteristic wastes and newly listed wastes.	May be applicable to listed or characteristically hazardous wastes for which a treatment standard has been promulgated, landfilling is planned, and the CAMU/TU regulations do not apply.
RCRA LDRs, Phase IV	40 CFR 268.30 and 268.40	Establishes specific land disposal prohibitions and treatment standards for wood-preserving wastes.	An ARAR because response actions will involve off-site treatment and disposal of F034 wastes.
Occupational Safety and Health Act (OSHA)	29 USC 651-578	Regulates worker health and safety.	Under 40 CFR 300.38, requirements of the act apply to all response activities under the NCP.

400123

Standard Requirements, Criteria, or Limitations	Citation	Description	Comments
Safe Drinking Water Act (SDWA)	40 CFR 144-147		
Underground Injection Control Regulations	40 CFR 144-147	Provides for protection of underground sources of drinking water.	Not an ARAR because response action does not involve groundwater remediation.
Hazardous Materials Transportation Act (HMTA)	49 USC 1801-1813		
Hazardous Material Transportation Regulations	49 CFR 107, 171-177	Regulates transportation of hazardous materials.	An ARAR because response action would involve transportation of hazardous materials.
Clean Air Act (CAA)	42 USC 7401		
Permitting	40 CFR 61	Requires permits for the discharge of pollutants for point sources, area sources, or fugitive emissions.	Substantive requirements for a permit will be required for discharge from the evacuation enclosure.

400124

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
Discharge of Groundwater or Wastewater				
Federal Clean Water Act	National Pollution Discharge Elimination System (NPDES)	40 CFR 122 and 125	Issues permits for discharge into navigable waters. Establishes criteria and standards for imposing treatment requirements on permits.	Disposal of groundwater to the surface water. NPDES permit may not be required since New Jersey has an approved SPDES permit program (NJDPES).
Federal Clean Water Act	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR 403	Prohibits discharge of pollutants to a POTW which cause or may cause pass-through or interference with operations of the POTW.	Discharge ot pollutants including those that could cause fire or explosion or result in toxic vapors or fumes to POTW.
Federal Clean Water Act	Effluent Guidelines and Standards for the Point Source Category	40 CFR 414	Requires specific effluent characteristics for discharge under NPDES permits.	Disposal of groundwater to the surface water. NPDES permit may not be required since New Jersey has an approved SPDES permit program (NJDPES).
Federal Safe Drinking Water Act	Underground Injection Control Program	40 CFR 144	Establishes performance standards, well requirements, and permitting requirements for groundwater re-injection wells.	Discharge of treated groundwater to potable water supply aquifer. May also apply to the injection of surfaciants or oxidants into the aquifer.
Federal Clean Water Act	Ambient Water Quality Criteria	40 CFR 131.36	Establishes criteria for surface water quality based on toxicity to aquatic organisms and human health.	Groundwater discharge to surface water. Federally-approved New Jersey groundwater and surface water standards take precedence over the Federal criteria.
Federal Clean Water Act	Water Quality Criteria Summary		Includes non-promulagated guidance values for surface water based on toxicity to aquatic organisms and human health. Issued by th EPA office of Science and Technology, Health and Ecological Criteria Division.	Groundwater discharge to surface water. Supplements above-referenced Ambient Water Criteria.
State of New Jersey Statutes and Rules	The New Jersey Pollutant Discharge Elimination System	N.J.A.C. 7:14A The New Jersey Pollutant Discharge Elimination System	Establishes standards for discharge of pollutants to surface and groundwaters.	New Jersey has a state approved program. Disposal of treated groundwater to surface water.
State of New Jersey Statutes and Rules	Groundwater Quality Standards	N.J.A.C. 7:9-6 Groundwater Quality Standards	Establishes standards for the protection of ambient groundwater quality. Used as the primary basis for setting numerical criteria for groundwater cleanups and discharges to groundwater.	Disposal of treated groundwater by reinjection.
State of New Jersey Statutes and Rules	Surface Water Quality Standards	N.J.A.C. 7:9B Surface Water Quality Standards	Establishes standards for the protection and enhancement of surface water resources.	Disposal of treated groundwater by discharge to surface water.

400125

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
Disposal of Hazardous Waste				
Federal Resource Conservation and Recovery Act	Identification and Listing of Hazardous Waste	40 CFR 261	Identifies solid wastes which are subject to regulation as hazardous wastes.	Generation os a hazardous waste possibly including spent carbon or contaminated soil. Hazardous waste must be handled and disposed of in accordance with RCRA. Chemical testing and characterization of waste required.
Federal Resource Conservation and Recovery Act	Standards Applicable to Generators of Hazardous Waste	40 CFR 262	Establishes requirements (e.g., EPA ID numbers and manifests) for generators of hazardous waste.	Waste that is characterized as hazardous.
Federal Resource Conservation and Recovery Act	Standards Applicable to Transporters of Hazardous Waste	40 CFR 263	Establishes standards which apply to persons transporting manifested hazardous waste within the United States.	Transport of waste that is characterized as hazardous.
Federal Resource Conservation and Recovery Act	Standards Applicable to Owners and Operators of Treatment, Storagem and Disposal Facilities	40 CFR 264	Establishes the minimum national standards which define acceptable management of hazardous waste.	Generation and storage of hazardous waste. May not apply to remediation sites if owner complies with requirements listed in 264, 1(j).
Federal Resource Conservation and Recovery Act	Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR 265	Establishes minimum national standards that define the perios of interim status and until certification of final closure or if the facility is subject to post-closure requirements, until post-closure responsibilities are fulfilled.	Remedies should be consistent with the more stringent PART 264 standards, as these represent the ultimate RCRA compliance standards and are consistent with CERCLA's goal of long-term protection of public health and welfare and the environment.
Federal Resource Conservation and Recovery Act	Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities	40 CFR 267	Establishes minimum standards that define acceptable management of hazardous wastes for new land disposal facilities.	Remedies should be consistent with the more stringent PART 264 standards, as these represent the ultimate RCRA compliance standards and are consistent with CERCLA's goal of long-term protection of public health and welfare and the environment.
Federal Resource Conservation and Recovery Act	Land Disposal Restrictions	40 CFR 268	Identifies hazardous wastes which are restricted from land disposal. All listed and characteristic hazardous waste or soil or debris contaminated by a RCRA hazardous waste and removed from a CERCLA site may not be land disposed until treated as required by LDRs..	Waste disposed as a RCRA waste.

400126

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
Disposal of Hazardous Waste (continued)				
Federal Resource Conservation and Recovery Act	Hazardous Waste Permit Program	40 CFR 270	Establishes provisions covering basic EPA permitting requirements.	A permit is not required for on-site CERCLA response actions. Substantive requirements are added in 40 CFR 264.
State of New Jersey Statutes and Rules	Hazardous Waste	N.J.A.C. 7:26C Hazardous Waste	Establishes rules for the operation of hazardous waste facilities in the state of New Jersey	
Federal Resource Conservation and Recovery Act	RCRA	40 CFR 265	Establishes organic air emission stndards for tanks, surface impoundments, and containers.	Applicable to hazardous waste treatment, storage, and disposal facilities (TSDFs) that receive new or re-issued permits or Class 3 modifications after 5 January 1995.
Federal Hazardous Material Transportation Act	Hazardous Materials Transportation Regulations	49 CFR 107, 171-177	Regulates transportation of hazardous materials.	An ARAR because response action would involve transportation of hazardous materials.
General Remediation				
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and Superfund Amendments and Reauthorization Act of 1986 (SARA)	National Contingency Plan	40 CFR 300, Subpart E	Outlines procedures for remedial actions and for planning and implementing off-site removal actions.	
State of New Jersey Statutes and Rules	Technical Requirements for Site Remediation	N.J.A.C. 7:26E Technical Requirements for Site Remediation	Established minimum regulatory requiremetns for investigation and remediation of contaminated sites in New Jersey.	
Federal Occupational Safety and Health Act	Worker Protection	29 CFR 1904	Requiremetns for recording and reporting occupation injuries and illnesses	Under 40 CFR 300.38, requirements of OSHA apply to all activities which fall under jusidiction of the National Contingency Plan.
Federal Occupational Safety and Health Act	Worker Protection	29 CFR 1910	Specifies minimum requirements to maintain worker health and safety during hazardous waste operations. Includes training requiremtns and construction safety requirements.	Under 40 CFR 300.38, requirements of OSHA apply to all activities which fall under jusidiction of the National Contingency Plan.
Federal Occupational Safety and Health Act	Worker Protection	29 CFR 1926	Safety and health regulations for construction.	Under 40 CFR 300.38, requirements of OSHA apply to all activities which fall under jusidiction of the National Contingency Plan.

400127

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
On-site Construction Activities				
New Jersey Uniform Construction Code	Establishes standards for all new construction and renovation.	N.J.A.C. 5:23	Establishes standards for all new construction and renovation.	This may be an ARAR to the extent that new construction falls within the standards.
Off-Gas Management				
Federal Clean Air Act	National Primary and Secondary Ambient Air Quality Standards	40 CFR 50	Establishes emission limits for six pollutants (SO2, PM10, CO, O3, NO2, and Pb).	Emission of ozone (O3) may be of concern for some remedial technologies utilizing ozone as an oxidizing agent. National limit is 8-hour, 0:08 ppm standard.
Federal Clean Air Act	Standards of Performance for New Stationary Sources	40 CFR 60	Provides emissions requirements for new staionary sources.	
Federal Clean Air Act	National Emission Standards for Hazardous Air Pollutants	40 CFR 61	Provides emission standards for 8 contaminants including benzene and vinyl chloride. Identifies 25 additional contaminants, as having serious health effects but does not provide emission standards for these contaminants.	
State of New Jersey Statutes and Rules	Standards for Hazardous Air Pollutants	N.J.A.C. 7:27 Air Pollution Control	Rule that govern the emitting of and such activities that result in the introductin of contaminants into the ambient atmosphere.	

400128

Appendix A

Potential Location-Specific ARARs

Martin Aaron Superfund Site

Type	Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
Within 100-Year Floodplain	New Jersey Flood Hazard Control Act	Floodplain Use and Limitations	N.J.A.C. 7:13 Flood Hazard Area Control	State standards for activities within flood plains.	An ARAR for those aspects of the site work that are within the flood plains.
Within 100-Year Floodplain	Federal National Environmental Policy Act (NEPA)	Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR 6, Appendix A	Establishes EPA policy and guidance for carrying out Executive Order 11988 - Protection of Floodplains and Executive Order Action must avoid adverse effects, minimize potential harm and restore and preserve natural and beneficial values of the floodplain.	Action will occur ina floodplain (lowlands and relatively flat areas adjoining inland) and coastal water and other flood-prone areas.
Wetlands	New Jersey Freshwater Protection Act		N.J.S.A. 13:9B-1; N.J.A.C. 7:7A	Require permits for regulated activity disturbing wetlands.	Potentially applicable for construction activities performed in the vicinity of a wetland or waterway.
Wetlands	Federal National Environmental Policy Act (NEPA)	Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR 6, Appendix A	11990 - Protection of Wetlands	Wetlands are defined by Executive Order 11990, Section 7 are present at or adjacent to the site.
Area Affecting Strem or River	Federal Clean Water Act	Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredge or Fill Material; Section 404 (c) Procedures; 404 Program Definitions; 404 State Program Regulations	40 CFR 230-233	Restricts discharge of dredged or fill material to wetlands or waters of the United States. Provides permitting program for situations with no other practical alternative.	Potentially applicable for construction activities performed in the vicinity of a wetland or waterway.
Area Affecting Strem or River	Federal Endangered and Non-Game Species Act	Protection of threatened and endangered species	N.J.S.A. 23:2A-1	Standards for the protection of threatened and endangered species.	Not an ARAR because no listed species identified at the site.
Area Affecting Strem or River	Federal Endangered Species Act	Protection of threatened and endangered species	16 USC 1531 et seq.; 40 CFR 400	Standards for the protection of threatened and endangered species.	Not an ARAR because no listed species identified at the site.
Area Affecting Strem or River	Federal Fish and Wildlife Conservation Act	Statement of Procedures for Non-game Fish and Wildlife Protection	16 USC 2901 et seq.	Establishes EPA policy and guidance for promoting the conservation of non-game fish and wildlife and their habitats. Action must protect fish or wildlife.	Potentially applicable for construction activities which may impact non-game fish and wildlife and their habitats.
	Federal National Historic Preservation Act	Procedures for preservation of historical and archaeological data	16 USC 469 et seq.; 40 CFR 6301(c)	Establishes procedures to provide for preservation of historical and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	If historical or archaeological data could potentially be encountered during remediation.

Appendix B
Detailed Cost Tables

Soil Media Alternatives Costs

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site: Martin Aaron Superfund Site, Camden, N. J.
Location: Soil Media
Phase: Feasibility Study

Base Year: 2005
Date: 7/8/2005 14:18

	Alternative S1 No Further Action	**Alternative S2** Cap and Institutional Controls	**Alternative S3** Cap, SVE and In Situ Stabilization	**Alternative S4** Cap, Excavation, Treatment and Offsite Disposal	**Alternative S5** Cap, SVE, Excavation, Treatment and Offsite Disposal	**Alternative S6** Total Excavation, Treatment and Offsite Disposal
Total Project Duration (Years)	50	50	50	50	50	1
Capital Cost	$0	$2,970,000	$3,240,000	$6,400,000	$5,800,000	$8,300,000
Annual O&M Cost	$0	$18,500	$125,900	$8,800	$125,900	$0
Total Periodic Cost	$0	$510,000	$320,000	$320,000	$320,000	$0
Total Present Value of Alternative	$0	$3,310,000	$3,630,000	$6,580,000	$6,190,000	$8,300,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within -50 to +100 percent of the actual project costs.

Alternative: **Alternative S1**
Name: **No Further Action**

COST ESTIMATE SUMMARY

Site: Martin Aaron Superfund Site, Camden, N. J.
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: 7/8/2005 14:18

Description: No additional actions undertaken other than the required 5 year reviews.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Alternative					
No construction				$0	
TOTAL CAPITAL COST				**$0**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	LS	$5,000	$0	
TOTAL ANNUAL O&M COST				**$0**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$0	$0	
5 year Review	10	1	LS	$0	$0	
5 year Review	15	1	LS	$0	$0	
5 year Review	20	1	LS	$0	$0	
5 year Review	25	1	LS	$0	$0	
5 year Review	30	1	LS	$0	$0	
5 year Review	35	1	LS	$0	$0	
5 year Review	40	1	LS	$0	$0	
5 year Review	45	1	LS	$0	$0	
5 year Review	50	1	LS	$0	$0	
				Total	$0	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1.000	$0	
ANNUAL O&M COST	1 to 50	$0	$0	13.80	$0	
PERIODIC COST	5	$0	$0	0.71	$0	
PERIODIC COST	10	$0	$0	0.51	$0	
PERIODIC COST	15	$0	$0	0.36	$0	
PERIODIC COST	20	$0	$0	0.26	$0	
PERIODIC COST	25	$0	$0	0.18	$0	
PERIODIC COST	30	$0	$0	0.13	$0	
PERIODIC COST	35	$0	$0	0.09	$0	
PERIODIC COST	40	$0	$0	0.07	$0	
PERIODIC COST	45	$0	$0	0.05	$0	
PERIODIC COST	50	$0	$0	0.03	$0	
		$0			$0	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$0**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative:	**Alternative S2**	**COST ESTIMATE SUMMARY**
Name:	**Cap and Institutional Controls**	

Site:	Martin Aaron Superfund Site, Camden, N. J.	**Description:** Institutional controls include deed notices describing the soil contamination and restrictions on site use and soil excavation.
Location:	Soil Media	Multilayer 12 inch Asphalt cap constructed over VOC Area > 10^{-4} and Arsenic > 500ppm and surrounding areas (Area 1)
Phase:	Feasibility Study	Single layer 4 inch asphalt cap constructed over remaining areas with PRGs > 10^-6 (Area 2).
Base Year:	2005	
Date:	7/8/2005 14:18	

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls	1	LS	$15,000	$15,000	Source 1
Predesign Investigations					
Investigation	1	LS	$75,000	$75,000	CH2M Est.
Multilayer Cap Area (Area 1- MA Property)					
Silt Fencing (MA Property)	2,100	FT	$3.36	$7,050	MEANS 18 05 0206
Clear and Grub	2.8	AC	$8,066	$22,768	MEANS 17 01 0106
Rough Grading	16,026	SY	$5.15	$82,465	MEANS 17 03 0101
Fine Grading	16,026	SY	$1.42	$22,784	MEANS 17 03 0103
Soil Excavation and Truck Loading	2,671	CY	$5.54	$14,801	MEANS 17 03 0276
Full TCLP Sample Analysis	4	EA	$500	$2,170	1 samp/ 800 CY, Analytical Services Center Quote
Subtitle D Landfill Disposal	3,472	CY	$30	$104,171	Model City Quoate
Gravel Base, 4 inches	1781	CY	$35	$61,523	MEANS 18-01-0102
Mutlilayer Cap 12"	2.8	AC	$360,000	$1,016,223	MatCon Quote
SUBTOTAL				$1,333,955	
Mobilization/Demobilization	5%			$66,698	Per CCI
Subcontractor General Conditions	15%			$47,660	Per CCI. Matcon costs only.
SUBTOTAL				$1,448,313	
Asphalt Cap Area (Area 2 - MA Property)					
Clear and Grub (MA Property)	1.1	AC	$8,066	$8,961	MEANS 17 01 0106
Fine Grading (MA Property)	5,377	SY	$1.42	$7,645	MEANS 17 03 0103
Rough Grading (MA Property)	5,377	SY	$5.15	$27,669	MEANS 17 03 0101
Gravel Base, 4 inches (MA Property)	896	CY	$35	$30,964	MEANS 18-01-0102
Asphalt Cap 4" (MA Property)	1.1	AC	$130,000	$144,430	MatCon Quote
SUBTOTAL				$219,668	
Mobilization/Demobilization	5%			$10,983	Per CCI
Subcontractor General Conditions	15%			$11,286	Per CCI. Matcon costs only.
SUBTOTAL				$241,937	
Building Demolition					
Demolish Masonary Wall	3,778	CF	$4.43	$16,736	MEANS 16-01-0110
Demolish Floor and Foundation	14,183	CF	$7.92	$112,263	MEANS 16-01-0102
Demolish Roof	21,274	SF	$0.44	$9,359	MEANS 16-01-0304
Asbestos, Lead and PCB Survey	1	LS	$10,000.00	$10,000	
Subtitle D Landfill Disposal	1,129	CY	$30	$33,874	Model City Quoate
SUBTOTAL				$182,232	
Mobilization/Demobilization	5%			$9,112	Per CCI
Subcontractor General Conditions	15%			$27,335	Per CCI
SUBTOTAL				$218,679	
SUBTOTAL				$1,998,929	
Contingency	25%			$499,732	10% Scope + 15% Bid
SUBTOTAL				$2,498,661	
Project Management	**5%**			$124,933	**USEPA 2000, p. 5-13, $2M-$10M**
Remedial Design	**8%**			$199,893	**USEPA 2000, p. 5-13, $2M-$10M**
Construction Management	**6%**			$149,920	**USEPA 2000, p. 5-13, $2M-$10M**
SUBTOTAL				$474,746	
TOTAL CAPITAL COST				**$2,970,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap Semi-annual Inspection	4	Hr	$60	$240	
Cap Repair	1.0	LS	$11,607	$11,607	Assumes 1% of area requires repair annually
Cap Inspection and Repair Report	1.0	LS	$500	$500	Biennial Report to NJDEP
SUBTOTAL				$12,347	
Contingency	30%			$3,704	10% Scope + 20% Bid
SUBTOTAL				$16,050	
Project Management	5%			$803	
Technical Support	10%			$1,605	
TOTAL ANNUAL O&M COST				**$18,500**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
Asphalt Cap Replacement	30	1	LS	$363,196	$363,196	Assume 30% of cap replaced
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
			Total		$510,000	
TOTAL ANNUAL PERIODIC COST					**$510,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$2,970,000	$2,970,000	1.000	$2,970,000	
ANNUAL O&M COST	1 to 50	$925,000	$18,500	13.801	$255,314	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$363,196	$363,196	0.13	$47,712	
PERIODIC COST	35	$15,000	$15,000	0.09	$1,405	
PERIODIC COST	40	$30,000	$30,000	0.07	$2,003	
PERIODIC COST	45	$15,000	$15,000	0.05	$714	
PERIODIC COST	50	$15,000	$15,000	0.03	$509	
		$4,400,000			$3,308,054	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$3,310,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

400134

Alternative: **Alternative S3** | **COST ESTIMATE SUMMARY**
Name: **Cap, SVE and In Situ Stabilization**

Site: Martin Aaron Superfund Site, Camden, N. J.
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: 7/8/2005 14:18

Description: In Situ solidification/stabilization of Arsenic >300 ppm in soil.
In Situ SVE of VOCs exceeding 10^-4 ELCR, HI=1 or NJDEP PRGs
and asphalt cap constructed over preceding area and area with VOCs, SVOCs,
Pesticides, PBCs and Metals exceeding 10^-6 ELCR, HI=1 or PRGs.
Institutional controls include deed notices describing the soil
contamination and restrictions on site use and soil excavation.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls	1	LS	$15,000	$15,000	Source 1
Predesign Investigations					
Investigation	1	LS	$100,000	$100,000	CH2M Est.
Stabilization Bench Scale Testing	1	LS	$20,000	$20,000	CH2M Est.
Pilot Scale Test for SVE Radius of Influence	1	LS	$100,000	$100,000	CH2M Est.
SUBTOTAL				$220,000	
Asphalt Cap Area					
Silt Fencing (MA Property)	2,100	FT	$3.36	$7,050	MEANS 18 05 0206
Clear and Grub (MA Property)	3.9	AC	$8,066	$31,729	MEANS 17 01 0106
Rough Grading (MA Property)	21,404	SY	$5.15	$110,134	MEANS 17 03 0101
Fine Grading (MA Property)	21,404	SY	$1.42	$30,429	MEANS 17 03 0103
Gravel Base, 4 inches (MA Property)	2,677	CY	$35	$92,487	MEANS 18-01-0102
Asphalt Cap 4" Base Course (MA Property)	3.9	AC	$130,000	$511,399	Matcon Quote
SUBTOTAL				$783,227	
Mobilization/Demobilization	5%			$39,161	Per CCI
Subcontractor General Conditions	15%			$40,774	Per CCI. Matcon costs only.
SUBTOTAL				$863,163	
In Situ Stabilization					
Mobilization/Demobilization	1	LS	$15,000	$15,000	Includes submittals; Bid
Mixing	2	MO	$53,400	$106,800	Lang Tool In Situ Blender
Cement	3,185	CY	$20	$63,704	Assumes 1:5 Ratio Cement:Soil
Full TCLP Analysis	32	EA	$500	$15,926	1 samp/ 100 CY, Analytical Services Center Quote
Operating Crew	50	DAY	$800	$40,000	3 person crew at $100/hr
SUBTOTAL				$301,787	Plus 25% for estimation
Soil Vapor Extraction/Catalytic Oxidation System					
Drilling/Well Construction - 2-inch	150	LF	$30	$4,500	SJB Services Quote
Drilling/Well Construction - 2-inch	30	LF	$30	$900	SJB Services Quote
Trenching	650	LF	$30	$19,500	Project Exper
Conveyance System	650	LF	$12	$7,800	Project Exper
Remediation Building w/ Electrical & HVAC	1	LS	$75,000	$75,000	Project Exper
SVE Process Equipment	1	LS	$75,000	$75,000	Project Exper
Pneumatic Pumps	15	EA	$3,000	$45,000	Project Exper
Vapor Treatment Equipment (GAC)	2	EA	$10,000	$20,000	Project Exper
Control System w/ Autodialer, Remote Telemetry	1	LS	$50,000	$50,000	Project Exper
Catalytic Oxidation System (Chlorinated)	3	MO	$4,000	$12,000	EPG Companies Quote
Startup - Labor	240	HRS	$80	$19,200	CH2M Est. - 2 persons
Equipment	1	LS	$2,000	$2,000	CH2M Est.
Consumables	1	LS	$1,000	$1,000	CH2M Est.
Laboratory Analysis of Vapor by TO-14	20	EA	$250	$5,000	CH2M Est.
Reporting	240	HRS	$80	$19,200	CH2M Est.
SUBTOTAL				$356,100	
Allowance for Misc. Items	20%			$71,220	
Fittings, Valves, Miscellaneous Appertanances	5%			$17,805	
Mobilization/Demobilization	5%			$17,805	
Subcontractor General Conditions	15%			$53,415	
SUBTOTAL				$516,345	
Soil Verification Sampling	1	LS		$50,000	CH2M Est.
Building Demolition					
Demolish Masonary Foundation Wall	3,778	CF	$4.43	$16,736	
Demolish Floor and Foundation	14,183	CF	$7.92	$112,263	MEANS 16-01-0102
Demolish Roof	21,274	SF	$0.44	$9,359	
Asbestos, Lead and PCB Survey	1	LS	$10,000.00	$10,000	
Subtitle D Landfill Disposal	1,129	CY	$30	$33,874	Model City Quoate
SUBTOTAL				$182,232	
Mobilization/Demobilization	5%			$9,112	Per CCI
Subcontractor General Conditions	15%			$27,335	Per CCI
SUBTOTAL				$218,679	
SUBTOTAL				$2,180,000	
Contingency	25%			$545,000	10% Scope + 15% Bid
SUBTOTAL				$2,725,000	
Project Management	5%			$136,250	**USEPA 2000, p. 5-13, $2M-$10M**
Remedial Design	8%			$218,000	**USEPA 2000, p. 5-13, $2M-$10M**
Construction Management	6%			$163,500	**USEPA 2000, p. 5-13, $2M-$10M**
SUBTOTAL				$517,750	
TOTAL CAPITAL COST				**$3,240,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap O&M					Year 1 to 50
Cap Semi-annual Inspection	4	Hr	$60	$240	
Cap Repair	1.0	LS	$5,114	$5,114	Assumes 1% of area requires repair annually
Cap Inspection and Repair Report	1.0	LS	$500	$500	Biennial Report to NJDEP
SUBTOTAL				$5,854	
Contingency	30%			$1,756	10% Scope + 20% Bid
SUBTOTAL				$7,610	
Project Management	5%			$381	
Technical Support	10%			$761	
SUBTOTAL Year 1 to 50				**$8,800**	
SVE O&M					Year 0 to 2
Routine Operations, Maintenance, Monitoring	625	Hr	$75	$46,875	
Laboratory Analysis (Water & Vapor)	12	Months	$2,000	$24,000	
Data Validation, Database Management	60	Hr	$80	$4,800	
Annual Report Preparation	80	Hr	$80	$6,400	
O&M Project Management	1	LS	$12,311	$12,311	15% of Subtotal
Electricity	12	Months	$1,100	$13,200	$0.11 per KW-Hr
GAC Usage	7500	LB	$1.04	$7,800	MEANS 33 13 1942
Contingency	30%			$1,756	10% Scope + 20% Bid
SUBTOTAL Year 0 to 2				**$117,142**	
TOTAL ANNUAL O&M COST Year 0 to 2				**$125,900**	
TOTAL ANNUAL O&M COST Year 3 to 50				**$8,800**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
Asphalt Cap Replacement	30	1	LS	$168,420	$168,420	Assume 30% of 4" cap replaced
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$320,000	
TOTAL ANNUAL PERIODIC COST					**$320,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$3,240,000	$3,240,000	1.000	$3,240,000	
ANNUAL O&M COST - SVE	0 to 2	$234,285	$117,142	1.808	$211,796	
ANNUAL O&M COST - Cap	1 to 50	$440,000	$8,800	13.8	$121,447	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$168,420	$168,420	0.13	$22,125	
PERIODIC COST	35	$15,000	$15,000	0.09	$1,405	
PERIODIC COST	40	$15,000	$15,000	0.07	$1,002	
PERIODIC COST	45	$15,000	$15,000	0.05	$714	
PERIODIC COST	50	$15,000	$15,000	0.03	$509	
		$4,200,000			$3,629,394	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$3,630,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

400135

Alternative:	**Alternative S4**		**COST ESTIMATE SUMMARY**
Name:	**Cap, Excavation, Treatment and Offsite Disposal**		

Site:	Martin Aaron Superfund Site, Camden, N. J.	**Description:**	Excavation of Arsenic >300 ppm in soil with offsite disposal. Ex situ stabilization of 50% and disposal at Subtitle D Landfill Remaining 50% of arsenic soil disposed without stabilization at Subtitle D Landfill. Excavation of VOC impacted soils > 10^-4 ELCR, stabilization assumed not needed, and disposed at Subtitle D Landfill. Excavated areas backfilled with clean certified material and and asphalt cap constructed over preceeding area and area with VOCs, SVOCs, Pesticides, PBCs and Metals exceeding 10^-6 ELCR, HI=1 or PRGs and excavated areas as well. Institutional controls include deed notices describing the soil contamination and restrictions on site use and soil excavation.
Location:	Soil Media		
Phase:	Feasibility Study		
Base Year:	2005		
Date:	7/8/2005 14:18		

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls	1	LS	$15,000	$15,000	Source 1
Predesign Investigations					
Investigation	1	LS	$50,000	$50,000	CH2M Est.
SUBTOTAL				$50,000	
Asphalt Cap Area					
Silt Fencing (MA Property)	2,100	FT	$3.36	$7,050	MEANS 18 05 0206
Clear and Grub (MA Property)	3.9	AC	$8,066	$31,729	MEANS 17 01 0106
Rough Grading (MA Property)	21,404	SY	$5.15	$110,134	MEANS 17 03 0101
Fine Grading (MA Property)	21,404	SY	$1.42	$30,429	MEANS 17 03 0103
Gravel Base, 4 inches (MA Property)	2,677	CY	$35	$92,487	MEANS 18-01-0102
Asphalt Cap 4" Base Course (MA Property)	3.9	AC	$130,000	$511,399	*Matcon Quote*
SUBTOTAL				$783,227	
Mobilization/Demobilization	5%			$39,161	Per CCI
Subcontractor General Conditions	15%			$40,774	Per CCI. Matcon costs only.
SUBTOTAL				$863,163	
Excavation					
Soil Excavation and Truck Loading	34,494	CY	$5.54	$191,140	MEANS 17-03-0276
Subtitle C Landfill Transport, Treatment and Disposal	10,352	CY	$114	$1,180,111	Model City Quote
Subtitle D Landfill Transport and Disposal	24,142	CY	$30	$724,273	Model City Quote
Clean Backfill	34,494	CY	$20	$689,886	Compacted, per CCI
Full TCLP Analysis	43	EA	$500	$21,559	1 samp/ 800 CY, Analytical Services Center Quote
SUBTOTAL				$2,806,969	
Mobilization/Demobilization	5%			$140,348	Per CCI
Subcontractor General Conditions	15%			$135,388	Per CCI. Less Disposal Costs.
SUBTOTAL				$3,082,705	
Soil Verification Sampling					
Soil Samples	1	LS	$50,000	$50,000	Project Exper
SUBTOTAL				$50,000	
Building Demolition					
Demolish Masonary Foundation Wall	3,778	CF	$4.43	$16,736	
Demolish Floor and Foundation	14,183	CF	$7.92	$112,263	MEANS 16-01-0102
Demolish Roof	21,274	SF	$0.44	$9,359	
Asbestos, Lead and PCB Survey	1	LS	$10,000.00	$10,000	
Subtitle D Landfill Disposal	1,129	CY	$30	$33,874	Model City Quote
SUBTOTAL				$182,232	
Mobilization/Demobilization	5%			$9,112	Per CCI
Subcontractor General Conditions	15%			$27,335	Per CCI
SUBTOTAL				$218,679	
SUBTOTAL				$4,280,000	
Contingency	25%			$1,070,000	10% Scope + 15% Bid
SUBTOTAL				$5,350,000	
Project Management	**5%**			$267,500	**USEPA 2000, p. 5-13, $2M-$10M**
Remedial Design	**8%**			$428,000	**USEPA 2000, p. 5-13, $2M-$10M**
Construction Management	**6%**			$321,000	**USEPA 2000, p. 5-13, $2M-$10M**
SUBTOTAL				$1,016,500	
TOTAL CAPITAL COST				**$6,400,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap Semi-annual Inspection	4	Hr	$60	$240	
Cap Repair	1	LS	$5,114	$5,114	Assumes 1% of area requires repair annually
Cap Inspection and Repair Report	1	LS	$500	$500	Biennial Report to NJDEP
SUBTOTAL				$5,854	
Contingency	30%			$1,756	10% Scope + 20% Bid
SUBTOTAL				$7,610	
Project Management	5%			$381	
Technical Support	10%			$761	
TOTAL ANNUAL O&M COST				**$8,800**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
Asphalt Cap Replacement	30	1	LS	$168,420	$168,420	Assume 30% of 4" cap replaced
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
			Total		$320,000	
TOTAL ANNUAL PERIODIC COST					**$320,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$6,400,000	$6,400,000	1.000	$6,400,000	
ANNUAL O&M COST	1 to 50	$440,000	$8,800	13.801	$121,447	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$168,420	$168,420	0.13	$22,125	
PERIODIC COST	35	$15,000	$15,000	0.09	$1,405	
PERIODIC COST	40	$30,000	$30,000	0.07	$2,003	
PERIODIC COST	45	$15,000	$15,000	0.05	$714	
PERIODIC COST	50	$15,000	$15,000	0.03	$509	
		$7,200,000			$6,578,600	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$6,580,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

400136

Alternative: **Alternative S5** — **COST ESTIMATE SUMMARY**

Name: **Cap, SVE, Excavation, Treatment and Offsite Disposal**

Site: Martin Aaron Superfund Site, Camden, N. J.
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: 7/8/2005 14:18

Description: In Situ SVE of VOC impacted soils > 10^-4 ELCR.
Excavation of arsenic impacted soils > 300 ppm along with ex situ treatment as needed (50% assumed).
Excavated areas backfilled with clean certified material and
asphalt cap constructed over preceeding area and area with VOCs, SVOCs,
Pesticides, PBCs and Metals exceeding 10^-6 ELCR, HI=1 or**PRGs**
and excavated areas as well. Institutional controls include deed notices describing the soil
contamination and restrictions on site use and soil excavation.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls	1	LS	$15,000	$15,000	Source 1
Predesign Investigations					
Investigation	1	LS	$50,000	$50,000	CH2M Est.
SUBTOTAL				$50,000	
Asphalt Cap Area					
Silt Fencing (MA Property)	2,100	FT	$3.36	$7,050	MEANS 18 05 0206
Clear and Grub (MA Property)	3.9	AC	$8,066	$31,729	MEANS 17 01 0106
Rough Grading (MA Property)	21,404	SY	$5.15	$110,134	MEANS 17 03 0101
Fine Grading (MA Property)	21,404	SY	$1.42	$30,429	MEANS 17 03 0103
Gravel Base, 4 inches (MA Property)	2,677	CY	$35	$92,487	MEANS 18-01-0102
Asphalt Cap 4" Base Course (MA Property)	3.9	AC	$130,000	$511,399	Matcon Quote
SUBTOTAL				$783,227	
Mobilization/Demobilization	5%			$39,161	Per CCI
Subcontractor General Conditions	15%			$40,774	Per CCI. Matcon costs only.
SUBTOTAL				$863,163	
Excavation of Arsenic Soil					
Soil Excavation and Truck Loading	20,704	CY	$5.54	$114,723	MEANS 17-03-0276
Subtitle C Landfill Transport, Treatment and Disposal	10,352	CY	$114	$1,180,111	Model City Quote
Subtitle D Landfill Transport and Disposal	10,352	CY	$30	$310,556	Model City Quote
Clean Backfill	20,704	CY	$20	$414,074	Compacted, per CCI
Full TCLP Analysis	26	EA	$500	$12,940	1 samp/ 800 CY, Analytical Services Center Quote
SUBTOTAL				$2,032,404	
Mobilization/Demobilization	5%			$101,620	Per CCI
Subcontractor General Conditions	15%			$81,261	Per CCI. Less Disposal Costs.
SUBTOTAL				$2,215,285	
Soil Vapor Extraction/Catalytic Oxidation System					
Drilling/Well Construction - 2-inch	150	LF	$30	$4,500	SJB Services Quote
Drilling/Well Construction - 2-inch	30		$30	$900	SJB Services Quote
Trenching	650	LF	$30	$19,500	Project Exper- M.G.
Conveyance System	650	LF	$12	$7,800	Project Exper- M.G.
Remediation Building w/ Electrical & HVAC	1	LS	$75,000	$75,000	Project Exper- M.G.
SVE Process Equipment	1	LS	$75,000	$75,000	Project Exper- M.G.
Pneumatic Pumps	15	EA	$3,000	$45,000	Project Exper- M.G.
Vapor Treatment Equipment (GAC)	2	EA	$10,000	$20,000	Project Exper- M.G.
Control System w/ Autodialer, Remote Telemetry	1	LS	$50,000	$50,000	Project Exper- M.G.
Catalytic Oxidation System (Chlorinated)	3	MO	$4,000	$12,000	EPG Companies Quote
Startup - Labor	240	HRS	$80	$19,200	CH2M Est. - 2 persons
Equipment	1	LS	$2,000	$2,000	CH2M Est.
Consumables	1	LS	$1,000	$1,000	CH2M Est.
Laboratory Analysis of Vapor by TO-14	20	EA	$250	$5,000	CH2M Est.
Reporting	240	HR	$80	$19,200	CH2M Est.
SUBTOTAL				$356,100	
Allowance for Misc. Items	20%			$71,220	
Fittings, Valves, Miscellaneous Appertanances	5%			$17,805	
Mobilization/Demobilization	5%			$17,805	
Subcontractor General Conditions	15%			$53,415	
SUBTOTAL				$516,345	
Soil Verification Sampling					
Soil Samples	1	LS	$50,000	$50,000	Project Exper- M.G.
SUBTOTAL				$50,000	
Building Demolition					
Demolish Masonary Foundation Wall	3,778	CF	$4.43	$16,736	
Demolish Floor and Foundation	14,183	CF	$7.92	$112,263	MEANS 16-01-0102
Demolish Roof	21,274	SF	$0.44	$9,359	
Asbestos, Lead and PCB Survey	1	LS	$10,000.00	$10,000	CH2M Est.
Subtitle D Landfill Disposal	1,129	CY	$30	$33,874	Model City Quoate
SUBTOTAL				$182,232	
Mobilization/Demobilization	5%			$9,112	Per CCI
Subcontractor General Conditions	15%			$27,335	Per CCI
SUBTOTAL				$218,679	
SUBTOTAL				$3,928,471	
Contingency	25%			$982,118	10% Scope + 15% Bid
SUBTOTAL				$4,910,589	
Project Management	5%			$245,529	USEPA 2000, p. 5-13, $2M-$10M
Remedial Design	8%			$392,847	USEPA 2000, p. 5-13, $2M-$10M
Construction Management	6%			$294,635	USEPA 2000, p. 5-13, $2M-$10M
SUBTOTAL				$933,012	
TOTAL CAPITAL COST				**$5,800,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap O&M					Year 1 to 50
Cap Semi-annual Inspection	4	HR	$60	$240	
Cap Repair	1.0	LS	$5,114	$5,114	Assumes 1% of area requires repair annually
Cap Inspection and Repair Report	1.0	LS	$500	$500	Biennial Report to NJDEP
SUBTOTAL				$5,854	
Contingency	30%			$1,756	10% Scope + 20% Bid
SUBTOTAL				$7,610	
Project Management	5%			$381	
Technical Support	10%			$761	
SUBTOTAL Year 1 to 50				**$8,800**	
SVE O&M					Year 0 to 2
Routine Operations, Maintenance, Monitoring	625	Hr	$75	$46,875	
Laboratory Analysis (Water & Vapor)	12	Months	$2,000	$24,000	
Data Validation, Database Management	60	Hr	$80	$4,800	
Annual Report Preparation	80	Hr	$80	$6,400	
O&M Project Management	1	LS	$12,311	$12,311	15% of Subtotal
Electricity	12	Months	$1,100	$13,200	$0.11 per KW-Hr
GAC Usage	7500	LB	$1.04	$7,800	MEANS 33 13 1942
Contingency	30%			$1,756	10% Scope + 20% Bid
SUBTOTAL				**$117,142**	
TOTAL ANNUAL O&M COST Year 0 to 2				**$125,900**	
TOTAL ANNUAL O&M COST Year 3 to 50				**$8,800**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
Asphalt Cap Replacement	30	1	LS	$168,420	$168,420	Assume 30% of 4" cap replaced
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$320,000	
TOTAL ANNUAL PERIODIC COST					**$320,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0% http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$5,800,000	$5,800,000	1.000	$5,800,000	
ANNUAL O&M COST - SVE	0 to 2	$234,285	$117,142	1.808	$211,796	
ANNUAL O&M COST - Cap	1 to 50	$440,000	$8,800	13.801	$121,447	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$168,420	$168,420	0.13	$22,125	
PERIODIC COST	35	$15,000	$15,000	0.09	$1,405	
PERIODIC COST	40	$15,000	$15,000	0.07	$1,002	
PERIODIC COST	45	$15,000	$15,000	0.05	$714	
PERIODIC COST	50	$15,000	$15,000	0.03	$509	
		$6,800,000			$6,189,394	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$6,190,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

400137

Alternative: **Alternative S6**
Name: **Total Excavation, Treatment and Offsite Disposal**

COST ESTIMATE SUMMARY

Site: Martin Aaron Superfund Site, Camden, N. J.
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: 7/8/2005 14:18

Description: Total excavation of all soils whose PRGs are > 10^-6 ELCR. Soils will be treated as necessary and disposed offsite at a landfill. 50% of arsenic soils assumed to be sslidified and disposed at Subtitle C landfill. Remainder of soils dispoosed at Subtitle D landfill.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Predesign Investigations					
Investigation	1	LS	$100,000	$100,000	
SUBTOTAL				$100,000	
Excavation					
Soil Excavation and Truck Loading (MA Property)	68,572	CY	$5.54	$379,973	MEANS 17-03-0276
Subtiltle C Landfill Transport, Treatment and Disposal	10,352	CY	$114	$1,180,128	Model City Quote
Subtiltle D Landfill Transport and Disposal	58,220	CY	$30	$1,746,612	Model City Quote
Clean Backfill (MA Property)	68,572	CY	$20	$1,371,448	Compacted, per CCI
Full TCLP Analysis (MA Property)	86	EA	$500	$42,858	1 samp/ 800 CY, Analytical Services Center Quote
SUBTOTAL				$4,721,019	
Mobilization/Demobilization	5%			$236,051	Per CCI
Subcontractor General Conditions	15%			$269,142	Per CCI. Less Disposal Costs.
SUBTOTAL				$5,226,212	
Soil Verification Sampling					
Soil Samples	1	LS	$100,000	$100,000	Project Exper- M.G.
SUBTOTAL				$100,000	
Building Demolition					
Demolish Masonary Foundation Wall	3,778	CF	$4.43	$16,736	
Demolish Floor and Foundation	14,183	CF	$7.92	$112,263	MEANS 16-01-0102
Demolish Roof	21,274	SF	$0.44	$9,359	
Asbestos, Lead and PCB Survey	1	LS	$10,000	$10,000	
Subtitle D Landfill Disposal	1,129	CY	$30	$33,874	Model City Quoate
SUBTOTAL				$182,232	
Mobilization/Demobilization	5%			$9,112	Per CCI
Subcontractor General Conditions	15%			$27,335	Per CCI
SUBTOTAL				$218,679	
SUBTOTAL				$5,644,891	
Contingency	25%			$1,411,223	10% Scope + 15% Bid
SUBTOTAL				$7,056,114	
Project Management	5%			$352,806	USEPA 2000, p. 5-13, >$10M
Remedial Design	6%			$423,367	USEPA 2000, p. 5-13, >$10M
Construction Management	6%			$423,367	USEPA 2000, p. 5-13, >$10M
SUBTOTAL				$1,199,539	
TOTAL CAPITAL COST				$8,300,000	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	Hr	$60	$0	
TOTAL ANNUAL O&M COST				$0	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	1	LS	$0	$0	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$8,300,000	$8,300,000	1.000	$8,300,000	
TOTAL PRESENT VALUE OF ALTERNATIVE					$8,300,000	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

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Estimated Quantities Calculations
Martin Aaron Superfund Site, Camden, N. J.
Soil Media
Feasibility Study

Description of Quantity

Estimated Quantities for:	Alternative S2		Cap and Institutional Controls
Silt Fencing MA Property	2,100	FT	Perimeter of MA Cap area = 552'+552'+469'+469'= 2042',
Clear and grub Area 1 (majority of MA property)	122,963	SF	
Clear and grub Area 1	2.8	AC	
Cap Area 1	144,237	SF	
Cap Area 1	16,026	SY	
Soil Excavation Volume for Grade establishment Area 1	2,671	CY	Assume an average of 0.5 foot of soil is removed over area.
Ex Situ Volume Area 1	3,472	CY	Assume 30% expansion
Gravel Base 0.5 ft Area 1	1781	CY	
Asphalt Cap Area 1	16,026	SY	
Asphalt Cap 4" Impermeable Layer Volume Area 1	1,781	CY	
Asphalt Cap 4" Leak Detection Layer Layer Volume Area 1	1,781	CY	
Clear and grub Area 2 (MA property)	48,395	SF	
Clear and grub Area 2 (MA property)	1.1	AC	
Cap Area 2 (MA Property)	48,395	SF	
Cap Area 2 (MA Property)	5,377	SY	
Gravel Base 0.5 ft Area 2 (MA Property)	896	CY	
Asphalt Cap 4" Impermeable Layer Volume Area 2 (MA)	597	CY	
Rhode Building Area	21,274	SF	Assume no significant Asbestos, Lead or PCBs.
Rhode Building Area Wall Volume	3,778	CF	Assume 1 story (10' high walls 6" thick). Total wall length ~ 756'.
Rhode Building Floor Volume	14,183	CF	Assumes 8" floor thickness.
Rhode Building Demolition Debris Volume	1,129	CY	Assumes Wall volume x 1.5 and roof volume = area x 0.5 ' thick and floor/foundation volume.

Additional Estimated Quantities for:	Alternative S3		Cap, SVE and In Situ Stabilization
MA Cap Area	192,632	SF	
MA Cap Area	4	AC	
In Situ Stabilization Area	43,000	SF	Arsenic Areas > 300 ppm. See Figure 4-2.
Soil Mixing Volume for In Situ Stabilization	15,926	CY	Assume an average of 10 ft mixing depth.
SVE Wells	15	EA	Screened 5 - 10'.
SVE InflowWells	15	EA	
Drilling/Well Construction Footage, 2-inch	150	LF	10' per SVE well.
Drilling/Well Construction Footage, 2-inch	30	LF	2' per inflow ell.
Trenching	650	LF	Based on conceptual layout, 2' deep, native pipe bedding/backfill material available . 635" rou
Electrical Costs	$1,100	MONTH	10,000 KW-Hr/Month @ $0.11/KW-Hr
Lang Tool Blender	$53,400	MO	Includes Slurry Mixing Truck, concrete placing pump and transportation costs.
GAC Usage	15,000	LB	Assume 900-1000 LB of VOC left to be extracted after Cat Ox.

Additional Estimated Quantities for:	Alternative S4		Cap, Excavation, Treatment and Offsite Disposal
Arsenic Soil Excavation Area	43,000	SF	
Arsenic Excavation Volume	15,926	CY	
Arsenic Ex Situ Volume	20,704	CY	
Arsenic Ex Situ Volume requiring Solid. and Sub. C Disposal	10,352	CY	50% requires solidification and disposal in a subtilte C landfill.
VOC Excavation Area	28,642	SF	
VOC Excavation Volume	10,608	CY	
VOC Ex Situ Volume	13,791	CY	
Total Ex Situ Excavation Volume	34,494	CY	
Clean Backfill	34,494	CY	

Additional Estimated Quantities for:	Alternative S6		Total Excavation, Treatment and Offsite Disposal
10' depth excavation area (MA Property)	125,432	SF	
10' depth excavation ex situ volume (MA Property)	60,393	CY	Assume 30% expansion
2' depth excavation area (MA Property)	42,469	SF	
2' depth excavation ex situ volume (MA Property)	4,090	CY	Assume 30% expansion
Arsenic Ex Situ Volume requiring Solid. and Sub. C Disposal	10,352	CY	50% requires solidification and disposal in a subtilte C landfill.

Unit Costs Derived from Means Unit Prices
Martin Aaron Superfund Site, Camden, N. J.
Soil Media
Feasibility Study

Means Category	Description	Units	Labor Unadjusted Cost	Labor Productivity Factor (a)	Labor Adjusted Cost	Equipment Unadjusted Cost	Equipment Productivity Factor	Equipment Adjusted Cost	Materials Cost	Subtotal	Local Cost Factor (b)	Subtotal	Contractor Mark-Up Overhead	Contractor Mark-Up Profit	Estimated Unit Cost
ENVIRONMENTAL REMEDIATION COST DATA - UNIT PRICE (Ref. 1)															
17-01-0106	Clear and Grub Heavy brush and Light Trees	AC	$2,729.00	82%	$3,328.05	$2,485.00	100%	$2,485.00	$0.00	$5,813.05	1.11	$6,452.48	15%	10%	$8,066
17-03-0101	Rough Grading	SY	$0.95	82%	$1.16	$2.55	100%	$2.55	$0.00	$3.71	1.11	$4.12	15%	10%	$5.15
17-03-0101	Fine Grading Grading	SY	$0.34	82%	$0.41	$0.61	100%	$0.61	$0.00	$1.02	1.11	$1.14	15%	10%	$1.42
17-03-0201	Excavation, Spoil to Side	CY	$0.43	82%	$0.52	$0.41	100%	$0.41	$0.00	$0.93	1.11	$1.04	15%	10%	$1.30
17-03-0276	Excavation, 1 Cy Hydraulic Excavator, Med. Mat'l, 40 CY/HR	CY	$1.52	82%	$1.85	$2.14	100%	$2.14	$0.00	$3.99	1.11	$4.43	15%	10%	$5.54
17-03-0202	Trenching, 1 CY Gradall, Light Soil, 95 CY per hour	CY	$1.71	82%	$2.09	$2.99	100%	$2.99	$0.00	$5.08	1.11	$5.63	15%	10%	$7.04
17-03-0401	Trench Backfill, 3 CY, 950	CY	$0.45	82%	$0.55	$0.66	100%	$0.66	$0.00	$1.21	1.11	$1.34	15%	10%	$1.68
17-03-0415	Backfill with excavated material	CY	$2.43	82%	$2.96	$0.81	100%	$0.81	$0.33	$4.10	1.11	$4.55	15%	10%	$5.69
17-03-0423	Backfill with Offsite Borrow; 6" Lifts, Spreading, Compaction	CY	$1.00	82%	$1.22	$2.10	100%	$2.10	$5.63	$8.95	1.11	$9.93	15%	10%	$12.42
18-01-0102	Gravel, Delivered & Dumped	CY	$1.78	82%	$2.17	$1.62	100%	$1.62	$21.11	$24.90	1.11	$27.64	15%	10%	$35
18-01-0105	Asphalt, Stabilized Base Course	CY	$0.61	82%	$0.74	$1.28	100%	$1.28	$32.38	$34.40	1.11	$38.19	15%	10%	$48
18-02-0101	Gravel, Delivered and Dumped	CY	$1.78	82%	$2.17	$1.62	100%	$1.62	$21.11	$24.90	1.11	$27.64	15%	10%	$35
18-02-0312	Asphalt Wearing Course	TN	$14.26	82%	$17.39	$14.24	100%	$14.24	$30.98	$62.61	1.11	$69.50	15%	10%	$87
18-05-0206	Silt Fence	LF	$1.41	82%	$1.72	$0.00	100%	$0.00	$0.70	$2.42	1.11	$3	15%	10%	$3.36
33-02-1705	TCLP VOC, SVOC, PCB and Metal Analysis	EA	$0.00	82%	$0.00	$0.00	100%	$0.00	$144.34	$144.34	1.11	$160	15%	10%	$200
33-02-0508	VOC Analysis	EA	$0.00	82%	$0.00	$0.00	100%	$0.00	$166.00	$166.00	1.11	$184	15%	10%	$230
33-19-0210	Dump Truck Transportation HW, 200-299 Miles	MI	$0.00	82%	$0.00	$0.00	100%	$0.00	$2.32	$2.32	1.11	$2.58	15%	10%	$3.22
33-19-0217	Dump Truck Transportation HW, 900-999 Miles	MI	$0.00	82%	$0.00	$0.00	100%	$0.00	$2.00	$2.00	1.11	$2.22	15%	10%	$2.78
16-01-0110	Remove Masonry Foundation Wall	CF	$1.47	82%	$1.79	$1.40	100%	$1.40	$0.00	$3.19	1.11	$3.54	15%	10%	$4.43
16-01-0102	Remove Concrete Footing	CF	$3.53	82%	$4.30	$1.40	100%	$1.40	$0.00	$5.70	1.11	$6.33	15%	10%	$7.92
16-01-0304	Remove Roofing - Built up	SF	$0.26	82%	$0.32	$0.00	100%	$0.00	$0.00	$0.32	1.11	$0.35	15%	10%	$0.44
33-19-7264	Landfill HW Disposal	CY	$0.00	82%	$0.00	$0.00	100%	$0.00	$148.00	$148.00	1.11	$164.28	15%	10%	$205
33-23-0101	2" PVC, Schedule 40, Well Casing	LF	$2.34	82%	$2.85	$6.67	100%	$6.67	$1.15	$10.67	1.11	$12	15%	10%	$15
33-23-0256	2" PVC, Schedule 40, Well Screen	LF	$3.92	82%	$4.78	$11.18	100%	$11.18	$2.07	$18.03	1.11	$20	15%	10%	$25
33-23-0555	4" Submersible Pump, 56-95 gpm, 41'<Head<100', 3 HP, w/ controls	EA	$0.00	100%	$0.00	$0.00	100%	$0.00	$3,042	$3,042.00	1.11	$3,377	15%	10%	$4,221
33-23-0561	4" Submersible Pump, 96-200 gpm, 101'<Head<150', 7.5 HP, w/ controls	EA	$0.00	100%	$0.00	$0.00	100%	$0.00	$4,481	$4,481.00	1.11	$4,974	15%	10%	$6,217
33-23-1180	Mob/demob, Drill Equipment or Trencher, Crew	EA	$438.25	82%	$534.45	$1,250.00	100%	$1,250.00	$243	$2,026.95	1.11	$2,250	15%	10%	$2,812
33-42-0101	Electrical Charge	KWH	$0.00	100%	$0.00	$0.00	100%	$0.00	$0.07	$0.07	1.11	$0.08	0%	0%	$0.08
33-42-0102	1.5 HP Motor, Electric Charge	MO	$0.00	100%	$0.00	$0.00	100%	$0.00	$62	$61.83	1.11	$69	0%	0%	$69
33-42-0106	Misc. Electrical Site Usage	MO	$0.00	100%	$0.00	$0.00	100%	$0.00	$275	$274.80	1.11	$305	0%	0%	$305

NOTES:

(a) Productivity factor of 82% applied to labor unit costs where applicable. See Ref. 1 for details.
(b) Local cost factor of 1.11 applied for the Warren County, New Jersey. See Ref. 1 for details.
(c) Subcontractor overhead (15%) and profit (10%) included in unit cost were applicable. See Ref 2 for details.

REFERENCES:

1. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA.
2. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Additional Unit Cost Information

Description	Units	Unit Cost	Notes
Soil Borings	LF	$47	Miller Drilling Quote
Subtitle D Landfill Transport and Disposal	CY	$30	Model City Quoate
Subtitle C Landfill Transport, Treatment and Disposal	CY	$114	Model City Quoate
Full TCLP Analysis	EA	$500	Analytical Services Center Quote

Groundwater Media Alternatives Costs

COMPARISON OF TOTAL COST OF REMEDIAL ALTERNATIVES

Site: Martin Aaron Superfund Site, Camden, N. J.
Media: Groundwater
Phase: Feasibility Study

Base Year: 2005
Date: 7/8/2005 14:15

	G1	G2	G3	G4	G5
	No Further Action	MNA and Institutional Controls	Containment with Hydraulic Controls	In Situ Geochemical Fixation and MNA	Groundwater Collection and Treatment
Total Project Duration (Years)	50	45	20	40	10
Capital Cost	$0	$24,000	$1,600,000	$1,200,000	$1,700,000
Annual O&M Cost	$0	$26,000	$580,000	$26,000	$700,000
Total Periodic Cost	$0	$140,000	$60,000	$120,000	$30,000
Total Present Value of Alternative	$0	$550,000	$7,800,000	$1,700,000	$6,600,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected

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Alternative: **G1** **COST ESTIMATE SUMMARY**

Name: **No Further Action**

Site: Martin Aaron Superfund Site, Camden, N. J.
Media: Groundwater
Phase: Feasibility Study
Base Year: 2004
Date: 7/8/2005 14:15

Description: No additional actions undertaken other than the required 5 year reviews.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
No construction				$0	
TOTAL CAPITAL COST				$0	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	LS	$0	$0	
TOTAL ANNUAL O&M COST				$0	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$0	$0	
5 year Review	10	1	LS	$0	$0	
5 year Review	15	1	LS	$0	$0	
5 year Review	20	1	LS	$0	$0	
5 year Review	25	1	LS	$0	$0	
5 year Review	30	1	LS	$0	$0	
5 year Review	35	1	LS	$0	$0	
5 year Review	40	1	LS	$0	$0	
5 year Review	45	1	LS	$0	$0	
5 year Review	50	1	LS	$0	$0	
				Total	$0	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1.000	$0	
ANNUAL O&M COST	1 to 50	$0	$0	13.80	$0	
PERIODIC COST	5	$0	$0	0.71	$0	
PERIODIC COST	10	$0	$0	0.51	$0	
PERIODIC COST	15	$0	$0	0.36	$0	
PERIODIC COST	20	$0	$0	0.26	$0	
PERIODIC COST	25	$0	$0	0.18	$0	
PERIODIC COST	30	$0	$0	0.13	$0	
PERIODIC COST	35	$0	$0	0.09	$0	
PERIODIC COST	40	$0	$0	0.07	$0	
PERIODIC COST	45	$0	$0	0.05	$0	
PERIODIC COST	50	$0	$0	0.03	$0	
		$0			$0	
TOTAL PRESENT VALUE OF ALTERNATIVE					$0	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **G2** **COST ESTIMATE SUMMARY**

Name: ***MNA and Institutional Controls***

Site: Martin Aaron Superfund Site, Camden, N. J.
Media: Groundwater
Phase: Feasibility Study
Base Year: 2005
Date: 7/8/2005 14:15

Description: Institutional controls includeClassification Exception Area. Confirmation groundwater sampling would be conducted every quarter for 2 years and then annually thereafter to assure that attenuation is occuring and that the plume is not moving.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	Source 1
Predesign Investigations					
Install 5 additional monitoring wells	5	LS	$1,785	$8,925	CH2M Est.
TOTAL CAPITAL COST				$23,925	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
GW MNA Sampling						
Groundwater Samples		21	LS	$360	$7,560	Contractor Estimate
QC Samples		6	LS	$360	$2,160	Contractor Estimate
Groundwater Sampling, Level D						
Labor		48	HRS	$80	$3,840	CH2M Est. - 2 persons
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		13.5	HRS	$80	$1,080	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$16,620	
Allowance for Misc. Items		20%			$3,324	
SUBTOTAL					$19,944	
Contingency		30%			$5,983	10% Scope + 20% Bid
SUBTOTAL					$25,927	
TOTAL ANNUAL O&M COST Year 0 to 2					$207,418	Quarterly for 2 years
TOTAL ANNUAL O&M COST Year 3 to 45					$25,927	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
				Total	$135,000	
TOTAL ANNUAL PERIODIC COST					$140,000	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$23,925	$23,925	1.000	$23,925	
ANNUAL O&M COST - Quarterly Sampling	0 to 2	$207,418	$103,709	1.808	$187,507	
ANNUAL O&M COST - Annual Sampling	3 to 45	$1,114,870	$25,927	13.606	$305,876	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
PERIODIC COST	35	$15,000	$15,000	0.09	$1,405	
PERIODIC COST	40	$15,000	$15,000	0.07	$1,002	
PERIODIC COST	45	$15,000	$15,000	0.05	$714	
		$1,481,212			$552,797	
TOTAL PRESENT VALUE OF ALTERNATIVE					$550,000	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: G3 **COST ESTIMATE SUMMARY**
Name: Containment with Hydraulic Controls

Site: Martin Aaron Superfund Site, Camden, N. J.
Media: *Groundwater*
Phase: Feasibility Study
Base Year: 2005
Date: 7/8/2005 14:15

Description: Institutional controls include Classification Exception Area. *Collect downgradient edge of the plume using 4 EWs, and discharge* Onsite chemical treatment and discharge effluent to POTW.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	Source 1
Predesign Investigations					
Install 5 additional monitoring wells	5	LS	$1,785	$8,925	CH2M Est.
Bench Scale Precipitation Testing	1	LS	$25,000	$25,000	
Pilot Scale Test	1	LS	$100,000	$100,000	
SUBTOTAL				$133,925	
EW Installation					
Mobilization/Demobilization	1	LS	$25,000	$25,000	Includes submittals;
Soil Borings	300	FT	$47	$13,950	Miller Drilling Quote.
6-inch PVC Well Casing	180	FT	$25	$4,431	33-23-0103
6-inch PVC Well Screen	120	FT	$44	$5,330	33-23-0203
Trenching	1,750	LF	$30	$52,500	Project Exper
Conveyance Piping	1,750	LF	$12	$21,000	Project Exper
Pumps	6	EA	$4,221	$25,325	MEANS 33-23-0555
SUBTOTAL				$147,535	
Treatment System					
Remediation Building w/ Electrical & HVAC	1	LS	$156,000	$156,000	MEANS SF Costs
Parkson Lamella Gravity Settler (LGS-300/55)	1	EA	$50,000	$50,000	
Parkson DynaSand Filter (DSF-19)	1	EA	$101,500	$101,500	Parkson Quote for Clarifier & Filter
3 CF Sludge Filter Press	1	EA	$13,500	$13,500	Parkson Quote
5,000 Gallon Tank (Oxidation Tank)	2	EA	$7,954	$15,908	33-10- 9660
Chemical Feeder (10 gph)	4	EA	$3,099	$12,396	33-12-9905
2,000 Gallon Tank (Coagulation Rxn Tank)	1	EA	$4,714	$4,714	33-10-9658
3000 Gallon Tank (Filtrate Storage Tank)	1	EA	$6,160	$6,160	33-10-9659
6,000 Gallon Tank (Sludge Storage Tank)	1	EA	$12,605	$12,605	33-10-9661
Mixer	3	EA	$4,362	$13,087	33-13-0428
Transfer Pump - 100 gpm	1	EA	$6,211	$6,211	33-23-0561
Transfer Pump - 35 gpm	2	EA	$3,864	$7,728	33-23-0562
Transfer Pump - 10 gpm	3	EA	$1,322	$3,967	33-23-0563
Hydrogen Peroxide Feed System	1	EA	$3,820	$3,820	33-33-0172
Control System w/ Autodialer, Remote Telemetry	1	LS	$50,000	$50,000	CH2M Est
Startup - Labor	240	HRS	$80	$19,200	CH2M Est. - 2 persons
Startup- Equipment	1	LS	$2,000	$2,000	CH2M Est.
Start-up- Consumables	1	LS	$1,000	$1,000	CH2M Est.
SUBTOTAL				$479,796	
Allowance for Misc. Items	20%			$95,959	
Fittings, Valves, Miscellaneous Appertanances	5%			$23,990	
Mobilization/Demobilization	5%			$23,990	
Subcontractor General Conditions	15%			$71,969	
SUBTOTAL				$695,704	
SUBTOTAL				$992,164	
Contingency	25%			$248,041	10% Scope + 15% Bid
SUBTOTAL				$1,240,205	
Project Management	6%			$74,412	USEPA 2000, p. 5-13, $2M-$10M
Remedial Design	12%			$148,825	USEPA 2000, p. 5-13, $2M-$10M
Construction Management	8%			$99,216	USEPA 2000, p. 5-13, $2M-$10M
SUBTOTAL				$322,453	
TOTAL CAPITAL COST				**$1,600,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
GW MNA Sampling						
Groundwater Samples		21	LS	$360	$7,560	Contractor Estimate .
QC Samples		6	LS	$360	$2,160	Contractor Estimate
Groundwater Sampling, Level D						
Labor		*48*	*HRS*	*$80*	*$3,840*	*CH2M Est. - 2 persons*
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		13.5	HRS	$80	$1,080	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$16,620	
Allowance for Misc. Items		20%			$3,324	
SUBTOTAL					$19,944	
Contingency		30%			$5,983	10% Scope + 20% Bid
SUBTOTAL					$25,927	
Treatment System						
Chemical Usage		1	LS	$45,000	$45,000	CH2M Est.
Cement for Solidification of Sludge		2	CY	$20	$30	CH2M Est.
Transport and Disposal of Solidified Sludge		7.5	CY	$100	$750	CH2M Est.
Routine Operations, Maintenance, Monitoring		2080	Hr	$80	$166,400	CH2M Est.
EW Monitoring Laboratory Analysis		84	EA	$360	$30,240	33-02-0508
Treatment System Laboratory Analysis		60	EA	$360	$21,600	VOC and metals analysis
Data Validation, Database Management		72	Hr	$80	$5,760	CH2M Est.
O&M Project Management		1	LS	$33,600	$33,600	15% of Sampling and Data Mgmt.
Electricity		12	Months	$150	$1,800	CH2M Est.
Reporting		1	LS	$20,000	$20,000	CH2M Est.
POTW User Fee Initial 4,000 CF		4,000	CF	0.019	$76	0 to 4000 CF (Camden Water, LLC Quote)
POTW User Fee FLOW > 4,000 CF		4,563,380	CF	0.023	$102,676	> 4000 CF (Camden Water, LLC Quote)
Electricity For EW Pumps		19,605	KWH	$0 08	$1,523	MEANS 33-42-0101
SUBTOTAL					$429,455	10% Scope + 20% Bid
Contingency		30%			$128,837	
SUBTOTAL					$558,292	
TOTAL ANNUAL O&M COST					**$580,000**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
					$60,000	
TOTAL ANNUAL PERIODIC COST					**$60,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7 0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$1,600,000	$1,600,000	1.000	$1,600,000	
ANNUAL O&M COST		$580,000	$580,000	10.594	$6,144,528	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0 36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
		$2,240,000			$7,772,161	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$7,800,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000)

400145

Alternative: **G4**

Name: **In Situ Geochemical Fixation and MNA**

COST ESTIMATE SUMMARY

Site: Martin Aaron Superfund Site, Camden, N. J.
Media: Groundwater
Phase: Feasibility Study
Base Year: 2005
Date: 7/8/2005 14:15

Description: Institutional controls include Classification Exception Area.
Fixate arsenic to low solubility precipitates in situ using a geochemical fixation method with Calcium Polysulfide.
MNA for VOCs.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	Source 1
Predesign Investigations					
Install 5 additional monitoring wells	5	LS	$1,785	$8,925	CH2M Est.
Bench Scale Testing	1	LS	$50,000	$50,000	
Pilot Scale Test	1	LS	$50,000	$50,000	
SUBTOTAL				$108,925	
In Situ Geochemical Fixation					
Mobilization/Demobilization	1	LS	$15,000	$15,000	Includes submittals; Bid
Mixing	6	MO	$53,400	$309,990	22 Day/Month. Minimum 500 CY/Day.
Calcium Polysulfide	123,030	LB	$0.093	$11,442	Assumes 3 mL/L Dose Rate. Tessenderlo KERLEY Quote.
Calcium Polysulfide Transport	3	Tanker	$5,000	$15,000	Quality Carriers, Inc. Quote
Lime Slurry for pH Adjustment	31	TON	$100	$3,076	Year 2000 Unit Cost Data
Storage Tanks	2	EA	$7,954	$15,908	MEANS 33-10- 9660
GW Analysis	1	LS	$25,000	$25,000	CH2M Est.
Operating Crew	128	DAY	$800	$102,169	3 person crew at $100/hr
SUBTOTAL				$621,980	Plus 25% for estimation
SUBTOTAL				$745,905	
Contingency	25%			$186,476	10% Scope + 15% Bid
SUBTOTAL				$932,381	
Project Management	6%			$55,943	USEPA 2000, p. 5-13, $500K-$2M
Remedial Design	12%			$111,886	USEPA 2000, p. 5-13, $500K-$2M
Construction Management	8%			$74,590	USEPA 2000, p. 5-13, $500K-$2M
SUBTOTAL				$242,419	
TOTAL CAPITAL COST				$1,200,000	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
GW MNA Sampling						
Groundwater Samples		21	LS	$360	$7,560	Contractor Estimate
QC Samples		6	LS	$360	$2,160	Contractor Estimate
Groundwater Sampling, Level D						
Labor		48	HRS	$80	$3,840	CH2M Est. - 2 persons
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		13.5	HRS	$80	$1,080	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$16,620	
Allowance for Misc. Items		20%			$3,324	
SUBTOTAL					$19,944	
Contingency		30%			$5,983	10% Scope + 20% Bid
SUBTOTAL					$25,927	
TOTAL ANNUAL O&M COST Year 0 to 2					$207,418	Quarterly for 2 years
TOTAL ANNUAL O&M COST Year 3 to 40					$25,927	

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
					$120,000	
TOTAL ANNUAL PERIODIC COST					$120,000	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$1,200,000	$1,200,000	1.000	$1,200,000	
ANNUAL O&M COST	1 to 2	$207,418	$103,709	1.81	$187,507	
ANNUAL O&M COST - Annual Sampling	3 to 40	$1,244,506	$25,927	13.332	$298,777	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
PERIODIC COST	35	$15,000	$15,000	0.09	$1,405	
PERIODIC COST	40	$15,000	$15,000	0.07	$1,002	
		$2,771,923			$1,721,058	
TOTAL PRESENT VALUE OF ALTERNATIVE					$1,700,000	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

400146

Alternative: G5
Name: Groundwater Collection and Treatment

COST ESTIMATE SUMMARY

Site: Martin Aaron Superfund Site, Camden, N. J.
Media: Groundwater
Phase: Feasibility Study
Base Year: 2005
Date: 7/8/2005 14:15

Description: Institutional controls include Classification Exception Area. Groundwater extraction collection with 13 EWs and treatment using a chemical precipitation process with discharge of treated effluent to the Camden POTW.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$15,000	$15,000	Source 1
Predesign Investigations					
Install 5 additional monitoring wells	5	LS	$1,785	$8,925	CH2M Est.
Bench Scale Precipitation Testing	1	LS	$25,000	$25,000	
Pilot Scale Test	1	LS	$100,000	$100,000	
SUBTOTAL				$133,925	
EW Installation					
Mobilization/Demobilization	1	LS	$25,000	$25,000	Includes submittals;
Soil Borings	650	FT	$47	$30,225	Miller Drilling Quote.
6-inch PVC Well Casing	390	FT	$25	$9,599	33-23-0103
6-inch PVC Well Screen	260	FT	$44	$11,548	33-23-0203
Trenching	3,000	LF	$30	$90,000	Project Exper- M.G.
Conveyance Piping	3,000	LF	$12	$36,000	Project Exper- M.G.
Pumps	13	EA	$3,000	$39,000	
SUBTOTAL				$241,373	
Treatment System					
Remediation Building w/ Electrical & HVAC	1	LS	$156,000	$156,000	MEANS SF Costs
Parkson Lamella Gravity Settler (LGS-300/55)	1	EA	$50,000	$50,000	
Parkson DynaSand Filter (DSF-19)	1	EA	$101,500	$101,500	Parkson Quote for Clarifier & Filter
3 CF Sludge Filter Press	1	EA	$13,500	$13,500	Parkson Quote
5,000 Gallon Tank (Oxidation Tank)	2	EA	$7,954	$15,908	33-10- 9660
Chemical Feeder (10 gph)	4	EA	$3,099	$12,396	33-12-9905
2,000 Gallon Tank (Coagulation Rxn Tank)	1	EA	$4,714	$4,714	33-10-9658
3000 Gallon Tank (Filtrate Storage Tank)	1	EA	$6,160	$6,160	33-10-9659
8,000 Gallon Tank (Sludge Storage Tank)	1	EA	$12,605	$12,605	33-10-9661
Mixer	3	EA	$4,362	$13,087	33-13-0428
Transfer Pump - 100 gpm	1	EA	$6,211	$6,211	33-23-0561
Transfer Pump - 35 gpm	2	EA	$3,864	$7,728	33-23-0562
Transfer Pump - 10 gpm	3	EA	$1,322	$3,967	33-23-0563
Hydrogen Peroxide Feed System	1	EA	$3,820	$3,820	33-33-0172
Control System w/ Autodialer, Remote Telemetry	1	LS	$50,000	$50,000	CH2M Est.
Startup - Labor	240	HRS	$80	$19,200	CH2M Est. - 2 persons
Startup- Equipment	1	LS	$2,000	$2,000	CH2M Est.
Start-up- Consumables	1	LS	$1,000	$1,000	CH2M Est.
SUBTOTAL				$479,796	
Allowance for Misc. Items	20%			$95,959.11	
Fittings, Valves, Miscellaneous Appertanances	5%			$23,989.78	
Mobilization/Demobilization	5%			$23,989.78	
Subcontractor General Conditions	15%			$71,969.33	
SUBTOTAL				$695,704	
SUBTOTAL				$1,086,001	
Contingency	25%			$271,500	10% Scope + 15% Bid
SUBTOTAL				$1,357,501	
Project Management	6%			$81,450	USEPA 2000, p. 5-13, $500K-$2M
Remedial Design	12%			$162,900	USEPA 2000, p. 5-13, $500K-$2M
Construction Management	8%			$108,600	USEPA 2000, p. 5-13, $500K-$2M
SUBTOTAL				$352,950	
TOTAL CAPITAL COST				$1,700,000	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
GW MNA Sampling						
Groundwater Samples		21	LS	$360	$7,560	Vocs, metals, MNA analysis
QC Samples		6	LS	$360	$2,160	Vocs and metals analysis
Groundwater Sampling, Level D						
Labor		48	HRS	$80	$3,840	CH2M Est. - 2 persons
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		13.5	HRS	$80	$1,080	CH2M Est.
Reporting		16	HRS	$80	$1,280	CH2M Est.
SUBTOTAL					$16,620	
Allowance for Misc. Items		20%			$3,324	
SUBTOTAL					$19,944	
Contingency		30%			$5,983	10% Scope + 20% Bid
SUBTOTAL					$25,927	
Treatment System						
Chemical Usage		1	LS	$60,000	$60,000	CH2M Est.
Cement for Solidification of Sludge		2	CY	$20	$40	CH2M Est.
Transport and Disposal of Solidified Sludge		10	CY	$100	$1,000	CH2M Est.
Routine Operations, Maintenance, Monitoring		2080	Hr	$80	$166,400	CH2M Est.
EW Monitoring Laboratory Analysis		168	EA	$360	$60,480	33-02-0508
Treatment System Laboratory Analysis		60	EA	$360	$21,600	VOC and metals analysis
Data Validation, Database Management		114	Hr	$80	$9,120	CH2M Est.
O&M Project Management		1	LS	$38,640	$38,640	15% of Sampling and Data Mgmt.
Electricity		12	Months	$200	$2,400	CH2M Est.
Reporting		1	LS	$20,000	$20,000	CH2M Est.
POTW User Fee Initial 4,000 CF		4,000	CF	0.019	$76	0 to 4000 CF (Camden Water, LLC Quote)
POTW User Fee FLOW > 4,000 CF		5,968,727	CF	0.023	$134,296	> 4000 CF (Camden Water, LLC Quote)
Electricity For EW Pumps		42,477	KWH	$0.08	$3,300	MEANS 33-42-0101
SUBTOTAL					$517,353	10% Scope + 20% Bid
Contingency		30%			$155,206	
SUBTOTAL					$672,559	
TOTAL ANNUAL O&M COST					$700,000	

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
SUBTOTAL					$30,000	
TOTAL ANNUAL PERIODIC COST					$30,000	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$1,700,000	$1,700,000	1.000	$1,700,000	
ANNUAL O&M COST	1 to 10	$7,000,000	$700,000	7.02	$4,916,507	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
		$8,730,000			$6,634,827	
TOTAL PRESENT VALUE OF ALTERNATIVE					$6,600,000	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

400147

TABLE QTY-1
Estimated Quantities Calculations
Martin Aaron Superfund Site, Camden, N. J.
Groundwater
Feasibility Study

Estimated Quantities for: G2 MNA and Institutional Controls

Groundwater MNA Samples	21	EA	MWs 1S, 5S, and MW Clusters MW-14, 15, 13, 18, 19, 20 and 11.

Estimated Quantities for: G3 Containment with Hydraulic Controls

EWs Soil Borings	300	FT	50 feet/boring x 6 borings = LF
EWs Well Casing	180	FT	30 feet/boring x 6 borings = LF
EWs Well Screens	120	FT	20 feet/boring x 6 borings = LF
Pipe trenching	1,750	LF	See Figure for layout
Groundwater EW Samples	84	EA	Assume 6 EW and one composit sample/month.
Treatment System Monitoring	60	EA	Assume influent, treatment tank effluent, filter effluent and 2 Qa/QC samples /month.
Annual Discharge to POTW @ 65 GPM	4,567,380	CF	
Electricity for EW Pumps	19,605	KWH	4 pumps @ 0.5 HP each @ 0.746KW/HP @8760 HR/YR

G4 In Situ Geochemical Fixation and MNA

In Situ Volume for Geochemical Fixation	63,856	CY	Depth to 17.5'
Lang Tool Blender On Site Time	128	DAY	Blender working @ rated minimum of 500 CY/DAY
Lang Tool Blender	53,400	MO	Includes Slurry Mixing Truck, concrete placing pump and transportation costs.
Calcium Polysulfide	123,030	LB	3 mL/L Dose Rate for Saturated Volume (>750mg/L Volume)
Calcium Polysulfide Tanker trucks	3	Trucks	Assumes 5,000 gallon trucks
$Ca(OH)_2$ for pH Adjustment	30.76	TON	Assume 2:1 Ratio for CaPs to $Ca(OH)_2$

G5 Groundwater Collection and Treatment

EWs Soil Borings	650	FT	50 feet/boring x 13 borings = LF
EWs Well Casing	390	FT	30 feet/boring x 13 borings = LF
EWs Well Screens	260	FT	20 feet/boring x 13 borings = LF
Pipe trenching	3,000	LF	See Figure for layout
Groundwater EW Samples	168	EA	Assume 13 EW and one composit sample/month.
Treatment System Monitoring	60	EA	Assume influent, treatment tank effluent, filter effluent and 2 Qa/QC samples /month.
Annual Discharge to POTW @ 85 GPM	5,972,727	CF	
Electricity for EW Pumps	42,477	KWH	13 pumps @ 0.5 HP each @ 0.746KW/HP @8760 HR/YR

Unit Costs Derived from Means Unit Prices
Martin Aaron Superfund Site, Camden, N. J.
Groundwater
Feasibility Study

Means Category	Description	Units	Labor Unadjusted Cost	Labor Productivity Factor (a)	Labor Adjusted Cost	Equipment Unadjusted Cost	Materials Cost	Subtotal	Local Cost Factor (b)	Subtotal	Contractor Mark-Up Overhead	Contractor Mark-Up Profit	Estimated Unit Cost
ENVIRONMENTAL REMEDIATION COST DATA - UNIT PRICE (Ref. 1)													
17-01-0106	Clear and Grub Heavy brush and Light Trees	AC	$2,729.00	82%	$3,328.05	$2,485.00	$0.00	$5,813.05	1.11	$6,452.48	15%	10%	$8,066
17-03-0101	Rough Grading	SY	$0.95	82%	$1.16	$2.55	$0.00	$3.71	1.11	$4.12	15%	10%	$5.15
17-03-0201	Excavation, Spoil to Side	CY	$0.43	82%	$0.52	$0.41	$0.00	$0.93	1.11	$1.04	15%	10%	$1.30
17-03-0276	Excavation, 1 Cy Hydraulic Excavator,	CY	$1.52	82%	$1.85	$2.14	$0.00	$3.99	1.11	$4.43	15%	10%	$5.54
17-03-0202	Trenching, 1 CY Gradall, Light Soil, 95 CY per hour	CY	$1.71	82%	$2.09	$2.99	$0.00	$5.08	1.11	$5.63	15%	10%	$7.04
17-03-0401	Trench Backfill, 3 CY, 950	CY	$0.45	82%	$0.55	$0.66	$0.00	$1.21	1.11	$1.34	15%	10%	$1.68
17-03-0415	Backfill with excavated material	CY	$2.43	82%	$2.96	$0.81	$0.33	$4.10	1.11	$4.55	15%	10%	$5.69
17-03-0423	Backfill with Offsite Borrow, 6" Lifts, Spreading, Compaction	CY	$1.00	82%	$1.22	$2.10	$5.63	$8.95	1.11	$9.93	15%	10%	$12.42
18-01-0102	Gravel, Delivered & Dumped	CY	$1.78	82%	$2.17	$1.62	$21.11	$24.90	1.11	$27.64	15%	10%	$35
18-01-0105	Asphalt, Stabilized Base Course	CY	$0.61	82%	$0.74	$1.28	$32.38	$34.40	1.11	$38.19	15%	10%	$48
18-02-0101	Gravel, Delivered and Dumped	CY	$1.78	82%	$2.17	$1.62	$21.11	$24.90	1.11	$27.64	15%	10%	$35
18-02-0312	Asphalt Wearing Course	TN	$14.26	82%	$17.39	$14.24	$30.98	$62.61	1.11	$69.50	15%	10%	$87
18-05-0206	Silt Fence	LF	$1.41	82%	$1.72	$0.00	$0.70	$2.42	1.11	$3	15%	10%	$3.36
18-05-0302	Deliver and Spread Topsoil	CY	$4.06	82%	$4.95	$2.89	$20	$28	1.11	$31	15%	10%	$39
18-05-0402	Hydroseeding and Watering	ACRE	$67.71	82%	$82.57	$52.39	$3,491	$3,626	1.11	$4,025	15%	10%	$5,031
33-02-1705	TCLP VOC Analysis	EA	$0.00	82%	$0.00	$0.00	$144.34	$144.34	1.11	$160	15%	10%	$200
33-02-0508	VOC Analysis	EA	$0.00	82%	$0.00	$0.00	$166.00	$166.00	1.11	$184	15%	10%	$230
33-08--0508	Geocomposit Membrane Liner	SF	$0.09	82%	$0.11	$0.07	$0.53	$0.71	1.11	$0.79	15%	10%	$0.98
33-10- 9657	1,000 Gallon Above-Ground Tank	EA	$557.20	82%	$679.51	$123.26	$1,163.00	$1,965.77	1.11	$2,182.01	15%	10%	$2,728
33-10- 9658	2,000 Gallon Above-Ground Tank	EA	$853.69	82%	$1,041.09	$123.26	$2,233.00	$3,397.35	1.11	$3,771.05	15%	10%	$4,714
33-10- 9659	3,000 Gallon Above-Ground Tank	EA	$878.79	82%	$1,071.70	$126.88	$3,241.00	$4,439.58	1.11	$4,927.93	15%	10%	$6,160
33-10- 9660	5,000 Gallon Above-Ground Tank	EA	$1,087.00	82%	$1,325.61	$156.87	$4,250.00	$5,732.48	1.11	$6,363.05	15%	10%	$7,954
33-10- 9661	8,000 Gallon Above-Ground Tank	EA	$1,245.00	82%	$1,518.29	$179.75	$7,387.00	$9,085.04	1.11	$10,084.40	15%	10%	$12,605
33-12-9905	Chemical Feeder	EA	$631.75	82%	$770.43	$0.00	$1,463.00	$2,233.43	1.11	$2,479.10	15%	10%	$3,099
33-13-0117	50-100 gpm cartridge Filter	EA	$46.04	82%	$56.15	$0.00	$4,567.00	$4,623.15	1.11	$5,131.69	15%	10%	$6,415
33-13-0428	2 HP, Double propeller 6" diameter mixer	EA	$50.00	82%	$60.98	$0.16	$3,083.00	$3,144.14	1.11	$3,489.99	15%	10%	$4,362.49
33-19-0210	Dump Truck Transportation HW, 200-299 Miles	MI	$0.00	82%	$0.00	$0.00	$2.32	$2.32	1.11	$2.58	15%	10%	$3.22
33-19-0217	Dump Truck Transportation HW, 900-999 Miles	MI	$0.00	82%	$0.00	$0.00	$2.00	$2.00	1.11	$2.22	15%	10%	$2.78
33-19-7264	Landfill HW Disposal	CY	$0.00	82%	$0.00	$0.00	$148.00	$148.00	1.11	$164.28	15%	10%	$205
33-23-0101	2" PVC, Schedule 40, Well Casing	LF	$2.34	82%	$2.85	$6.67	$1.15	$10.67	1.11	$12	15%	10%	$15
33-23-0103	6" PVC, Schedule 40, Well Casing	LF	$3.37	82%	$4.11	$9.60	$4.03	$17.74	1.11	$20	15%	10%	$25
33-23-0203	6" PVC, Schedule 40, Well Screen	LF	$5.61	82%	$6.84	$16.00	$9.17	$32.01	1.11	$36	15%	10%	$44
33-23-0256	2" PVC, Schedule 40, Well Screen	LF	$3.92	82%	$4.78	$11.18	$2.07	$18.03	1.11	$20	15%	10%	$25
33-23-0555	4" Submersible Pump, 56-95 gpm, 41'<Head<100', 3 HP, w/ controls	EA	$0.00	100%	$0.00	$0.00	$3,042	$3,042.00	1.11	$3,377	15%	10%	$4,221
33-23-0561	4" Submersible Pump, 96-200 gpm, 101'<Head<150', 7.5 HP, w/ controls	EA	$0.00	100%	$0.00	$0.00	$4,481	$4,481.00	1.11	$4,974	15%	10%	$6,217
33-23-1180	Mob/demob, Drill Equipment or Trencher, Crew	EA	$438.25	82%	$534.45	$1,250.00	$243	$2,026.95	1.11	$2,250	15%	10%	$2,812
33-26-0406	4" PVC Piping, with Fittings	LF	$9.81	82%	$11.96	$0.45	$2.96	$15.37	1.11	$17.06	15%	10%	$21.33
33-23-0561	Centrifugal Pump, 50 GPM, 100' Head, 3 HP	EA	$321.48	100%	$321.48	$0.00	$557	$878.91	1.11	$976	15%	10%	$1,219
33-29-0123	Transfer Pump, 100 GPM, 5 HP	EA	$927.62	100%	$927.62	$0.00	$3,549	$4,476.62	1.11	$4,969	15%	10%	$6,211
33-29-0120	Transfer Pump, 35 GPM, 1 HP	EA	$579.78	100%	$579.78	$0.00	$2,205	$2,784.78	1.11	$3,091	15%	10%	$3,864
33-29-0101	Transfer Pump, 10 GPM, 1/6 HP	EA	$119.26	100%	$119.26	$0.00	$834	$953.00	1.11	$1,058	15%	10%	$1,322
33-33-0172	Hydrogen Peroxide Feed System	EA	$863.90	100%	$863.90	$64.10	$1,825	$2,753.00	1.11	$3,056	15%	10%	$3,820
33-42-0101	Electrical Charge	KWH	$0.00	100%	$0.00	$0.00	$0.07	$0.07	1.11	$0.08	0%	0%	$0.08
33-42-0102	1.5 HP Motor, Electric Charge	MO	$0.00	100%	$0.00	$0.00	$62	$61.83	1.11	$69	0%	0%	$69
33-42-0106	Misc. Electrical Site Usage	MO	$0.00	100%	$0.00	$0.00	$275	$274.80	1.11	$305	0%	0%	$305

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NOTES:

(a) Productivity factor of 82% applied to labor unit costs where applicable. See Ref. 1 for details.
(b) Local cost factor of 1.11 applied for the Warren County, New Jersey. See Ref. 1 for details.
(c) Subcontractor overhead (15%) and profit (10%) included in unit cost were applicable. See Ref 2 for details.

REFERENCES:

1. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA.
2. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Additional Unit Cost Information

Description	Units	Unit Cost	Notes	
Soil Borings	LF	$47	Miller Drilling Quote	
Potassium Permanganate	LB	$1.75	Envirox phone quote of $1.40/lb + 25% for contractor OH and profit.	
Subtitle D Landfill Transport and Disposal	CY	$100	Bethlem, Pa. Landfill quote	
VOC Analysis	EA	$95		Steven Paukner/CH2M Hill Chemist
Metals Analysis	EA	$95		Steven Paukner/CH2M Hill Chemist
NO3, SO4,Sulfide,Methane, Ethane, Ethene Analysis	EA	$110		Steven Paukner/CH2M Hill Chemist
BOD, COD Analysis	EA	$40		Steven Paukner/CH2M Hill Chemist
TOC Analysis	EA	$20		Steven Paukner/CH2M Hill Chemist
Total of VOCs, Metals and MNA parameters	Ea	$360		